POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

Contents

Strange Doings in Pittsburgh 388

With the Editors 389
Nationalizing the T.V.A. Electric Paralysis.

Steel Point Installs 5000-kw. Top 390

Superheat Control. By R. Stark von Roger 398

What Every Plant Should Have 400

Solid CO_2 From Flue Gas 401

Improved Steam Boilers at a Dutch Power Station. By C. J. Webb 401

Turbine Water Rates Are Not Mysterious. By G. R. Probst 402

Diesel Lubrication—a New Approach. By E. H. Hillman 406

Diesel Fuel Pump Application. By H. C. Edwards 408

Koppitz Pale Select Beer for Detroit 410

Electron Tubes—Principles and Applications. By A. W. Kramer 414

Edison Electric Institute Meets at Chicago 418

Unusual Brush Trouble. By L. L. Stoffel 422

Automatic Temperature Control Grows in Popularity 424

Soldering Pipe Threads to Prevent Oil Leaks. By Wm. J. Hart 425

Remedies for Furnace Explosions. By C. C. Custer 428

Newport Electric Corporation Adds Hydro Capacity. By L. G. Ropes 430

Freezing a Dam 433

Annual Convention of the N.D.H.A. 434

Large Generator Shaft Extracted with Dry Ice 436

Coast to Coast Diesel Service 437

Readers Conference 438

New Equipment 442

News from the Field 446

For the Engineers Library 448

Power Plant Construction News 450

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

JULY
1937

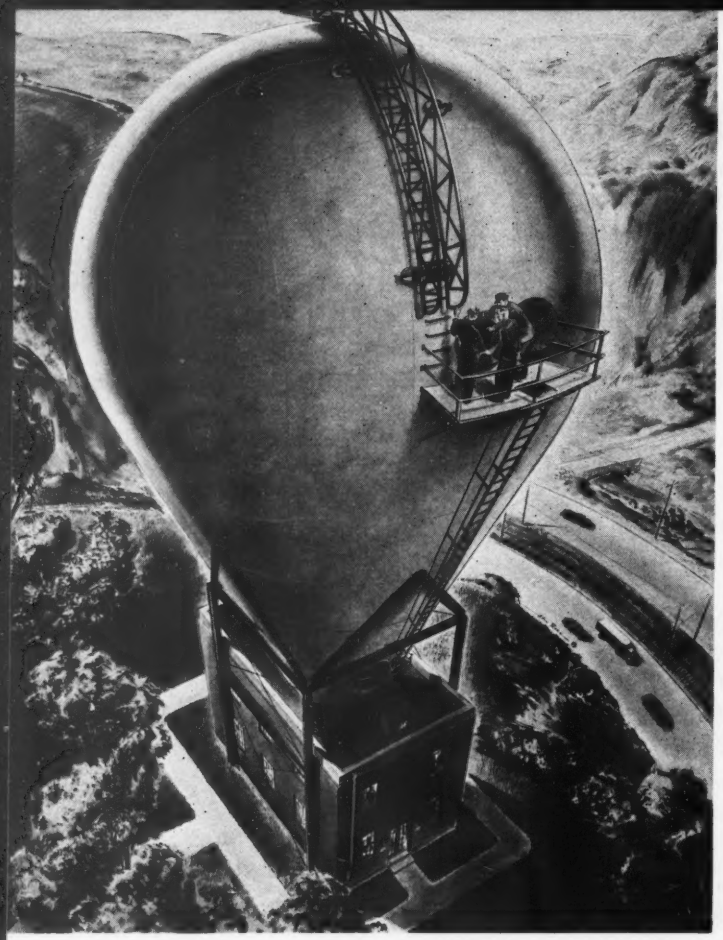
Vol. XLI., No. 7

Published on the first of each month, copyright 1937 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editor. R. E. TURNER, Managing Editor.
A. W. KRAMER, RICHARD H. MORRIS, Associate Editors.

Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.
Circulation of this issue, 19,000



Strange Doings in Pittsburgh

THERE'S SOMETHING FUNNY going on in Pittsburgh. For some time the inhabitants of that city have been wondering whether they were victims of a strange hallucination or whether the funny looking object pictured above was actually becoming a part of the landscape. Reports had variously likened it to a balloon, a ham, a top, or a pear growing out of a building, but there was never a clue as to its purpose. Our inquiring reporter, always on the lookout for startling developments in any line, including blonds, removed his feet from his desk the instant he heard about it and within the week grabbed a plane for the smokey city where he interviewed the first natives he collided with.

"Yep," quoted Isoceles Hiccough, when questioned, "I seen it wit my own eyes; the consarnest, queerest contraption yuh iver see—a sort of a top squattin' on the roof of a firehouse. 'Sgot a hole in it; gosh durned if I kin make anything out of it."

Mr. Hiccough's penetrating observations were confirmed by Garabaldi Garlicco, distinguished member of the Pittsburgh Street Department. "Yoobettcha de boots, mister," stated Garabaldi, as he deftly scooped up a bit of foreign matter from the streets of this well-known American city, "I seea him. Joosta likea beega ham onda roof, Santa Maria Lucia—"

Our reporter did not wait to hear the rest of Mr. Garlicco's remarks; he had heard enough and hurried on to his next victim, so to speak, who proved to be a personage of somewhat greater erudition than either Messrs. Hiccough or Garlicco; indeed, it was no less an authority than P. Percival Plimpweed of the linear waistcoat laboratory at the Pittsburgh Irrational Institute.

"Ah, yes, to be sure," confided Professor Plimpweed, peering suspiciously around through his horn rimmed spectacles as though he was afraid someone would find him, "I have observed the structure you refer to. A strange device—a distended oblate spheroid of what I should term the fourth order, resembling somewhat a large tuber such as might have been indigenous to the early mesozoic; an astonishing object to the purpose of which I have devoted great study. You see I have a theory—"

But our reporter had no time for theories; he is interested only in facts and so he was off—he usually is. It is a small world, however, and before he had fully recovered from the Professor's eloquence he ran, right smack, into a gentleman of oriental extraction—Willie Hop Sing. "Sure," beamed Willie, flattered, "me seeie him. Great big ball. Clazy Amelican man build him—damfool, nobody home. Amelican man he climbee up; get in hole; no comie out. Clazy in head."

Now, here was a mystery! Evidently this strange device, whatever it might be, drew men into its interior. Perhaps it held some irresistable fatal attraction. Who knows—but why theorize? Why not go and see?

No sooner had the thought entered his head than our hero was off again. He had not gone far, however, when he met a group of Westinghouse engineers (Pittsburgh is full of 'em) and being an old Westinghouse man himself, there ensued great handshaking. It appeared they were on their way to the E. E. I. convention in Chicago.

"Come along, old man," they urged. "There's going to be big doings. Gus Dyer's going to make a speech, Frank Smith's going to play the harmonica and we're going to have dancing and wine at the banquet——"

At the mention of these last two items our reporter picked up his ears, figuratively speaking of course, but straightway he thought of his duty and said, "No boys, I'm here to clear up a mystery—the mystery of the ball on top of the firehouse, the oblate spheroid, the tuber——"

"Oh, phoey," shouted the Westinghouse gang. "Is that all? We know all about that. 'Smatter of fact, Dr. Chubb here is going to give a lecture on it at the convention. Come along and you'll find out all about it."

Little more remains to be said. Needless to say our hero went to the E. E. I. Convention. He hasn't recovered yet but we found his report in his pocket and are presenting it in this issue on page 418.

WITH THE EDITORS

Nationalizing the TVA—

FOR WANT of a more expressive and descriptive term needed during a formative period, TVA is rapidly losing its original significance and becoming, for the moment, a symbol of national salvation on one side and political domination and persecution on the other.

Bills now before Congress would blanket the entire nation with eight regional authorities modeled after the present TVA. The Senate bill (S2555 said to have administration support and introduced by Norris), differs from the House bill (HR7365 introduced by Mansfield) primarily in regard to regulation. The latter would give the Federal Power Commission jurisdiction over power rates while the former would leave each authority free from even this nominal restriction.

Such legislation has been under consideration for some months and was requested in a special message from the President because: "Nature has given recurrent and poignant warnings through dust storms, floods and droughts that we must act while there is still time if we would preserve for ourselves and posterity the natural resources of a virile national life."

The fundamental need for some form of national or regional planning to take care of these matters is not in question, the difference of opinion being one of degree. Like the TVA, however, the proposed legislation brooks no half way measures but gives the several authorities complete domination of all industry involved in any way in territory affected by the rather flexible limits of navigable streams.

"No dam, appurtenant works, sewer, dock, pier, wharf, bridge, trestle, landing, pipe, building, float, or other or different obstruction or polluter affecting navigation, the use of navigable waters, flood control and prevention, the public lands, or property of the United States, shall be constructed, or thereafter operated or maintained, over, across, along, in or into any navigable stream or any tributary thereof, except in accordance with plans for such construction, operation, and maintenance which shall theretofore have been submitted to and approved by the Authority within whose geographic region such obstruction or polluter is to be constructed, operated, or maintained. The requirements of this section shall be in addition to the requirements of all other applicable laws of the United States or of any state." Each Authority is also granted the right of condemnation "necessary or appropriate for or reasonably incidental" to carrying out its purpose.

Although droughts, floods, navigation, reclamation of public lands and national defense are the open issues involved with power not mentioned in the purpose and policy of the act, the entire trend of the bill shows that there can no longer be any question but that the immediate and definite purpose of the group interested in this legislation is the complete national control of power. Whether the complete extinction of private power companies is contemplated is not known, but it is apparent that private power companies have been singled out for specific attention and could exist only on sufferance, subject to the whims of each new administration and with no guarantee of safety.

This fight for existence by the private utilities is no longer a local affair of the TVA area but nationwide and what, if any, concerted action will be taken by the industry remains to be seen. Inasmuch as power control is one of the fundamentals of Roosevelt's New Deal philosophy, there is little question of its final adoption in some form. The outcome will depend upon the utility industry which must carry on its battle unaided. If, however, power is so important an aspect of national planning, it should stand or fall on its own merits as a single issue and not under a thin disguise, unmentioned by name.

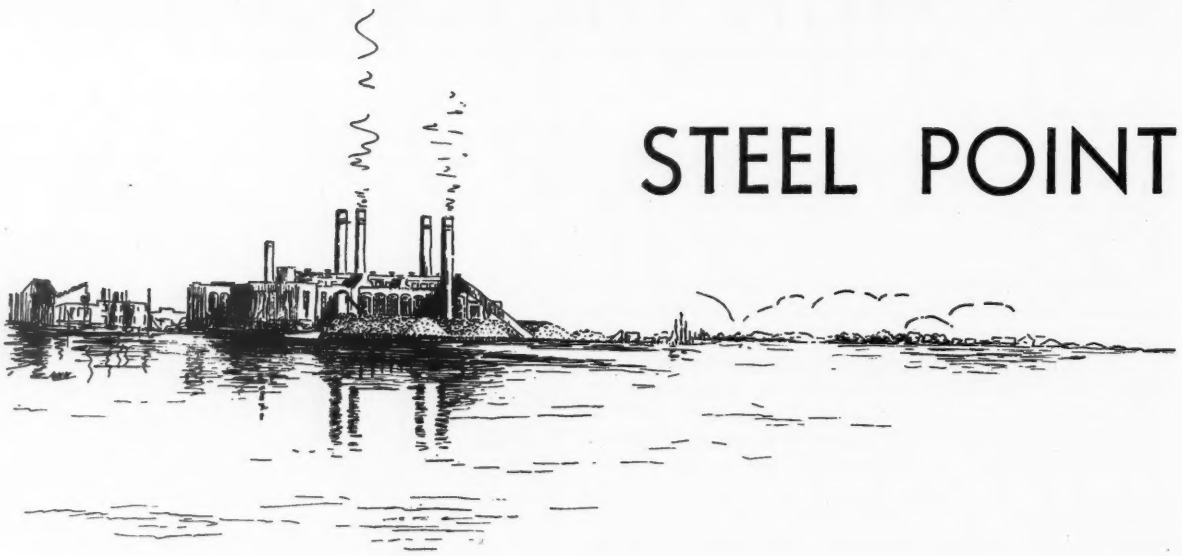
Danger to the nation as a whole lies not in this narrow angle, however, but in the fact that the Norris Bill would give the several authorities a virtual strangle hold over all industry.

Some day, if the unequal fight against nature is successful, it may be desirable to go to such lengths. Today it certainly is not. Navigation rights and needs are but legal hangovers from Revolutionary days. Flood control is not compatable with power generation in significant amounts. Drought control, beyond limited areas under irrigation, has yet to be demonstrated as feasible. In emergencies national defense always takes precedence over civil rights.

Regardless of pressing needs or political convictions, such complete dominance of the nation by such unregulated groups responsible to no one could not be justified even if definite and practical plans were possible and had already been made to handle the conflicting needs of the various problems. The power problem should not be considered seriously except as part of a definite national policy, a step which the administration refuses to make publicly until it has complete control. Under the circumstances this request is totally unwarranted, doubly so pending the outcome of the Public Utility Act court decisions.

Electric Paralysis

NORTHEASTERN Michigan recently suffered a stroke of electric paralysis affecting some 190 cities and villages, throwing 75,000 industrial workers out of work for half a day at a cost to them of $200,000. Living, industrial and traffic conditions as we know them today were chaotic, even dangerous. It took but a short time to convince the Governor of Michigan that this was an intolerable emergency. Just a few words from him to a local president of the U. A. W. and modern conditions were restored. This paralysis has struck twice, so far, in the same place. Will the third stroke prove fatal, and to whom—the utility, the union or the political authorities who condone antics detrimental to the welfare of a whole section of a state? Such burlesqueing of governmental obligations would be laughable if its consequences were not so far reaching, so costly and so dangerous to the health and safety of the citizenry.



STEEL POINT

THOSE, whose business or pleasure occasionally takes them along the shore line of the New York, New Haven and Hartford Railroad between New York and Boston and who are even remotely interested in power plants, cannot fail to have noticed a splendid looking power station rising up rather conspicuously across the harbor at Bridgeport, Conn., as the train stops for a few minutes there. For many years this station has been a landmark; it has graced Bridgeport Harbor with its pleasing architectural lines and the water seems to lend a romantic touch which at times must penetrate even the heart of a prosaic engineer.

This structure is the Steel Point Station of the United Illuminating Co. which, together with another plant at New Haven, serves Bridgeport, New Haven and a number of other towns and communities along the Connecticut shore. Built in 1920 with six boilers and a single 12,500-kv-a. generator, it was added to in 1922, 1925 and 1927 until it had a total of twenty boilers and seven turbogenerators involving an installed capacity of 100,000 kv-a. The first three units are rated at 12,500 kv-a. each while the last four are 15,625-kv-a. units, all of General Electric manufacture. The boilers were all fired by underfeed stokers. The general arrangement of these machines and the station layout as a whole is shown in Fig. 1.

Built in the decade of intense power plant expansion, between 1920 and 1930, Steel Point Station continually incorporated the latest developments as they were made available. Simple in its fundamental design, its layout meets the requirements of convenient operating practice to such an extent that the station has acquired a reputation for reliability. For many years under the excellent supervision of its chief engineer, Oscar J. Richmond, it has been one of New England's notable stations.

From its beginning the steam pressure carried at Steel Point has been 225 lb. The last boilers were installed in 1927 and at that time high pressure technique was just beginning to be developed. In the years since 1927, of course, no additional capacity was required and so the station carried on with this pressure until the present time.

Last year, however, in view of the development of high pressure technique and the high efficiencies obtainable thereby, it seemed desirable to install additional capacity and so plans were made to install a high pressure section, involving the steam generating equipment and auxiliaries necessary for a 5000-kw. high pressure, non-condensing turbine-generating unit. This superposed or "top" unit was installed during the latter part of last year and now serves as a base load unit, operated by high pressure and high temperature steam at the turbine inlet and exhausting at the same steam pressure as previously generated by the stoker fired boilers.

Fundamentally, this unit is similar to many now being installed in plants throughout the country. It operates in conjunction with two or more of the condensing turbine-generators to form a compound unit, expanding steam from an initial pressure of 615 lb. gage and 830 deg. F. total steam temperature to the existing condenser vacuum.

For all station loads above about 17,500 kw., this 5000-kw. generating unit operates at full load or 6250 kv-a. at 80 per cent power factor. Due to its high back pressure, this turbine requires at least three times as much steam per kw-hr. as do the condensing turbines. The steam exhausting from the 5000-kw. turbine is approximately 620 deg. F. at full load and this temperature adds approximately 100 deg. F. additional superheat to the steam available to the condensing turbines, thus reducing their steam rate per kilowatt-hour. The unit, therefore, is primarily an economy unit to reduce the coal rate per kilowatt-

INSTALLS 5000 KW. "TOP"

Two 11,100 square feet integral furnace boilers operating at 625 lb. pressure and a new 5000 kw. non-condensing turbogenerator increases the thermal efficiency of this well-known New England Station.

hour and at the same time to increase the plant capacity by 6250 kv-a.

Not the least interesting among the various aspects of this new installation is the care and thought exercised on the part of the management and the consulting engineers to train and instruct the personnel in the operation of the unit. Being the first pulverized coal unit in the station, its operation obviously entails an entirely different technique from that required for the old boilers. The combustion control system is much more elaborate and the high rate of operation requires a different point of view—a pulverized coal plant is more sensitive to its control than is a stoker fired plant.

In order to train the operators in the technique of operating this installation, Westcott and Mapes, Inc., of New Haven, Conn., who designed and constructed the station originally and who also designed and installed this new unit, prepared a 200-page book of operating instructions, complete in every detail, with drawings and diagrams of the equipment and with full information regarding the nature of the system. This book was given to the operators and courses inaugurated which everyone could attend. A few new men experienced in the operation of these units were added to the station operating force and some of the existing operators were sent to other plants to study the operation of similar boilers while the new unit was under construction. In this way the entire personnel, from the lowliest fireman to the company executives were given an opportunity to become familiar with the new installation.

In this book an attempt was made to acquaint the personnel with every detail of the system, in a way which would enable the operators to study it whenever they had the opportunity. Figure 4 for example

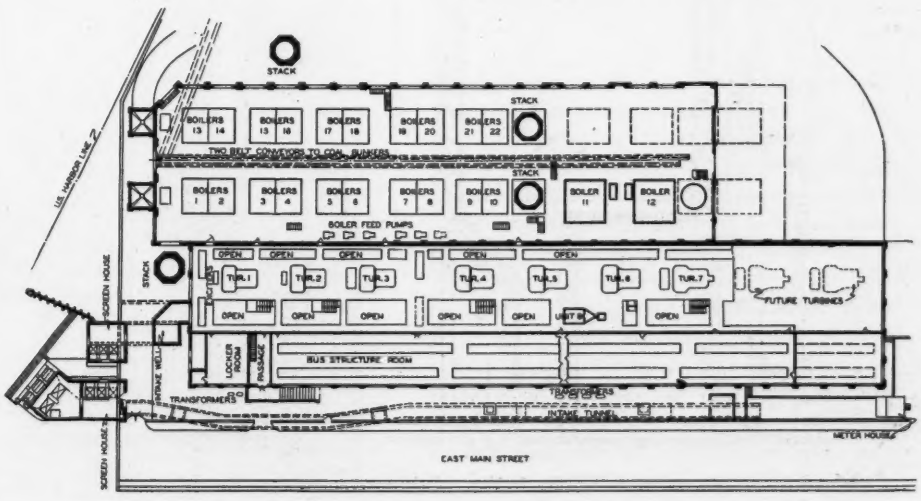
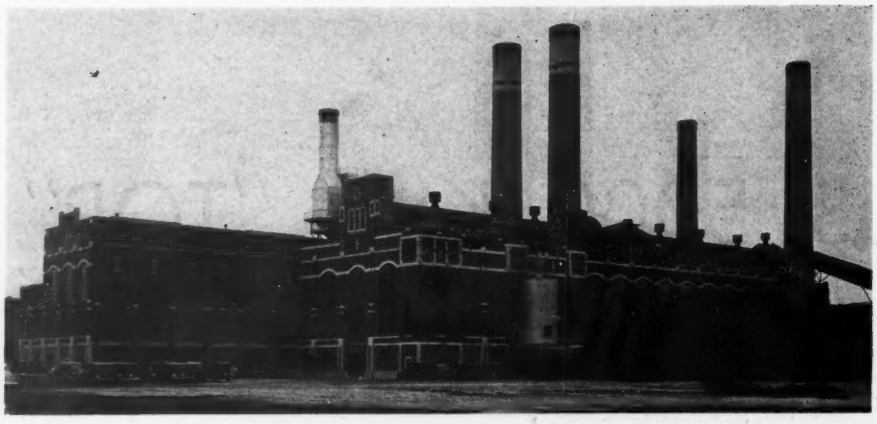


Fig. 1. General Plan of Steel Point Station. This plan shows the position of the new boilers, Nos. 11 and 12 with respect to the old units. The new high pressure turbine is shown here as No. 8.



Steel Point Station

The new boilers are served by the short steel stack shown at the left

is a drawing of the main steam and water lines as presented in these operating instructions. This drawing is an attempt to show what the piping system would look like to an observer some distance in the air at the northwest corner of the boiler room with all interfering walls and equipment invisible.

Figure 5 is the flow diagram for practically the same piping.

The 625 lb. Steam System

Referring to the piping diagram, steam enters the main 625 lb. header through the two boiler leads and there are two paths by which the steam may leave it. The one which is used most is through the turbine lead to the new 5000-kw. turbine. The second path goes directly from the 625 lb. header to the present 225 lb. header through a reducing valve and a desuperheater. Large expansion loops are provided to take up the great amount of expansion that occurs in piping operated at over 800 deg. In this particular case the expansion amounts to about 7 in. for every 100 ft. of pipe. The 625 lb. piping system is constructed of carbon-molybdenum alloy steel.

The 5000-kw. turbine exhausts steam at about 210 lb. into the present main header. Under certain conditions (such as low turbine load) the exhaust from the 5000-kw. turbine may be at a somewhat higher temperature than is well to use in the present 225 lb. turbines. Consequently, a desuperheater is placed in the turbine exhaust line. Also, since the exhaust pressure must be constant to agree with that in the present main steam header, the turbine is governed by a connection from the exhaust line back to the turbine.

Feedwater

Feedwater for the new boilers is heated in a deaerating heater by steam which is taken from the present 225 lb. header. Therefore, there is a line leading from the header to the heater through a pressure reducing valve which can be by-passed if necessary. The steam leaves the reducing valve at about 205 lb. and goes directly to the heater. This slight reduction in pres-

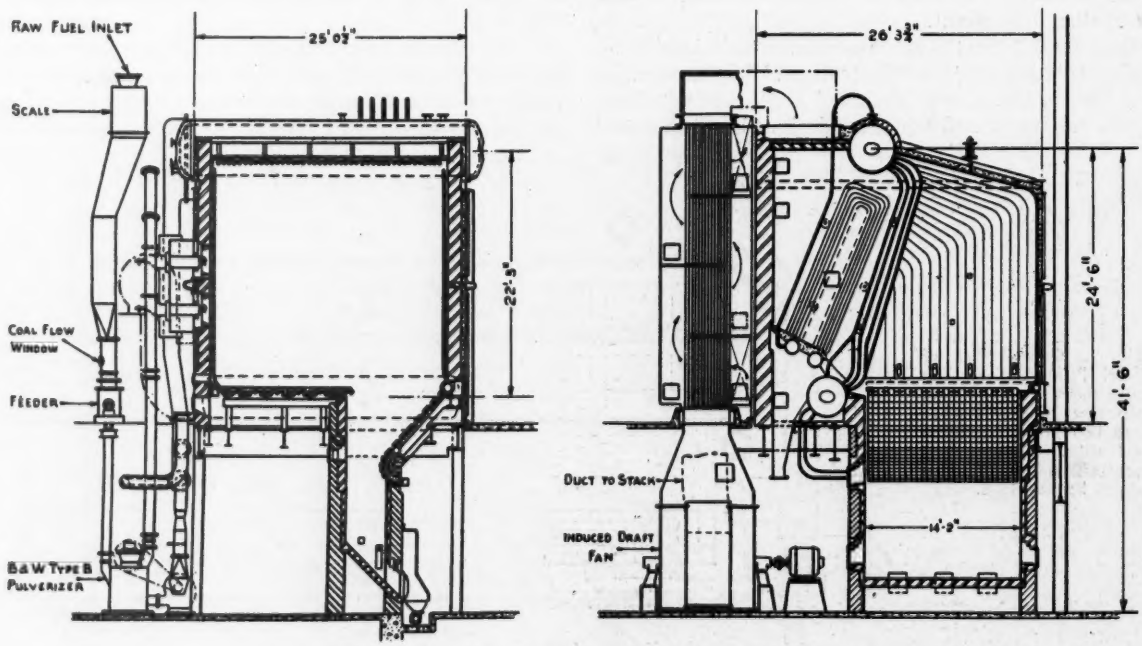
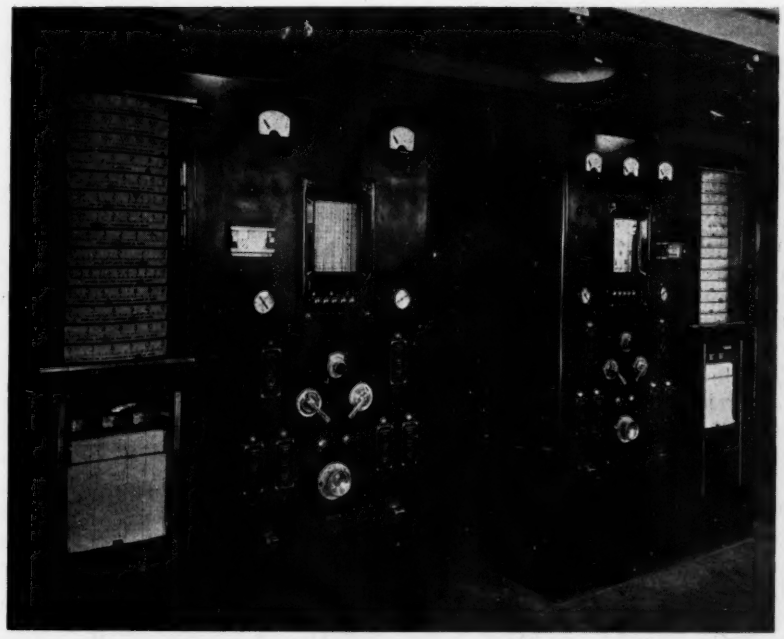
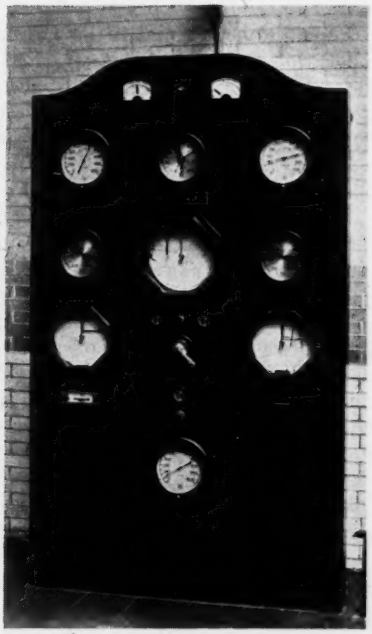
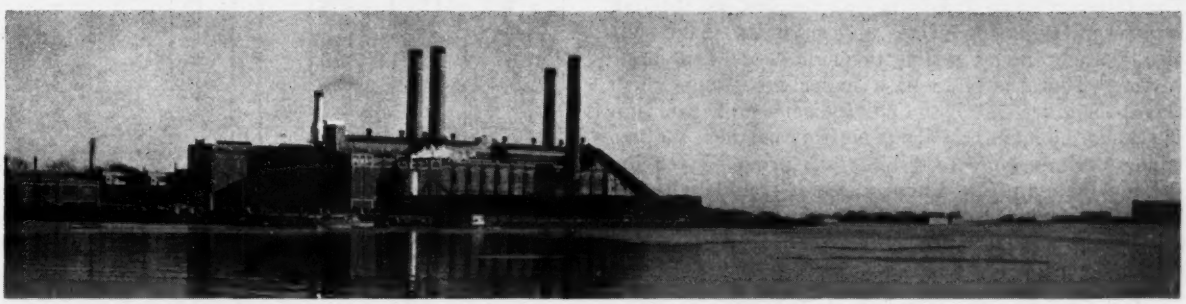
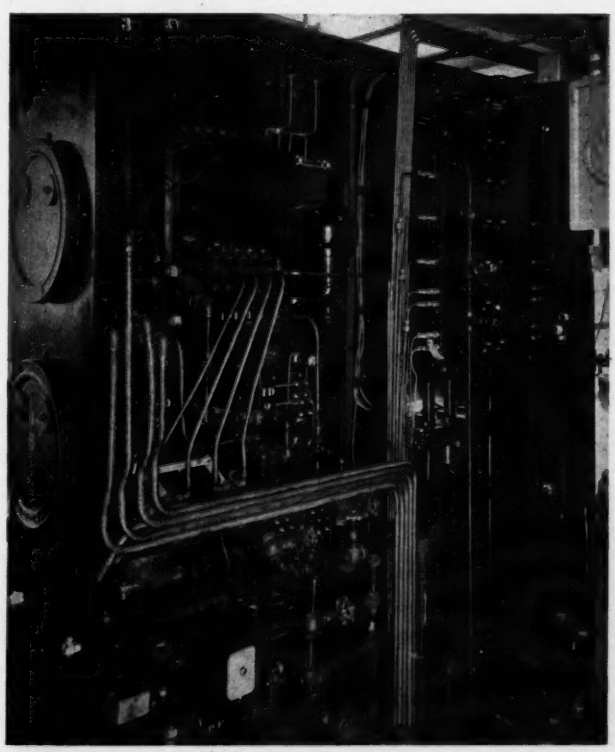


Fig. 2. Plan and elevation of one of the two new boilers.









Automatic Control At Steel Point

On this page are shown views of the automatic combustion control apparatus at Steel Point Station. At the top, left, are shown the two boiler panels with their elaborate array of instruments and controls. Note particularly the multiple instrument array on each board, and the recording instruments below. The rear view of one of these panels is shown at the lower left. From these panels and the master control board shown above at the right, the entire operation of these two boilers is automatically controlled. By merely throwing a lever, however, the control can be shifted to "manual" and the various motors and devices controlled by means of the push buttons shown on the front of the boiler panels.

sure is provided simply in order to have constant pressure in the heater and is not absolutely essential to its operation. The selection of this particular pressure does, however, fix the pressure and temperature within the heater and likewise the pressure in several lines leading from it. The deaerating heater has a capacity of 250,000 lb. per hr. heating the water from 210 to 390 deg. F.

The 260 lb. water is feedwater coming from the present feedwater system. It is normally fed to the vent condenser above the heater through a regulating valve. In case of trouble with the vent condenser or regulating valve, a by-pass leads directly to the heater. If the entire heater is out of service a second by-pass leads directly to the suction side of the boiler feed pumps. The water leaves the deaerating heater at about 205 lb. pressure, and flows directly to the suction lines of the boiler feed pumps. There are two 5-stage, centrifugal boiler feed pumps, each with a capacity of 254,000 lb. per hr. One pump therefore can handle the boiler load leaving the other as a spare.

Water leaves the boiler feed pump at 900 lb. pressure by two separate lines which enter the feed pump discharge header. The main feed line leaves one end of this header and leads to branch lines to the boilers. The latter run up the fronts of the boilers through feedwater regulating valves and enter the front ends of the upper boiler drums through check and angle valves. There is a by-pass boiler feed line which leaves the other end of the pump discharge header and this joins the main line about midway between the two boilers. Emergency feed lines are provided for bypassing the main feed lines in case of trouble with the feedwater regulators or valves in the main feed lines. These lines enter the boiler drums at the rear.

As shown in the flow diagram, a continuous blowdown system is provided, which maintains the boiler water concentration at the desired value and which at the same time recovers most of the heat in the water withdrawn. Two flash tanks are provided in this system, a high pressure tank which is connected into the high pressure deaerating heater and a low pressure flash tank which is connected to the low pressure open heaters in the existing system.

Provision for sampling the boiler water is made by running branches from the blow-down lines to a sampling manifold through needle valves which provide means for drawing off the sample at a convenient rate. The sampling manifold has one outlet leading to a test water cooling coil in which the sample is cooled to about room temperature before being collected for analysis. One object of cooling the sample is to prevent any change in its concentration caused by evaporation occurring when hot water is exposed to the open air. In addition, the water which passes through the sampling needle valve tends to flash into steam to a very considerable extent and this steam must be recondensed. The test water cooling coil is composed of one tube within another so arranged that the sample flows through the inner tube and cold city water flows through the outer tube.

Having described the principal features of the new system as a whole we will now proceed to a more detailed consideration of the principal units in the system, the new boilers, the combustion apparatus and the high pressure turbine.

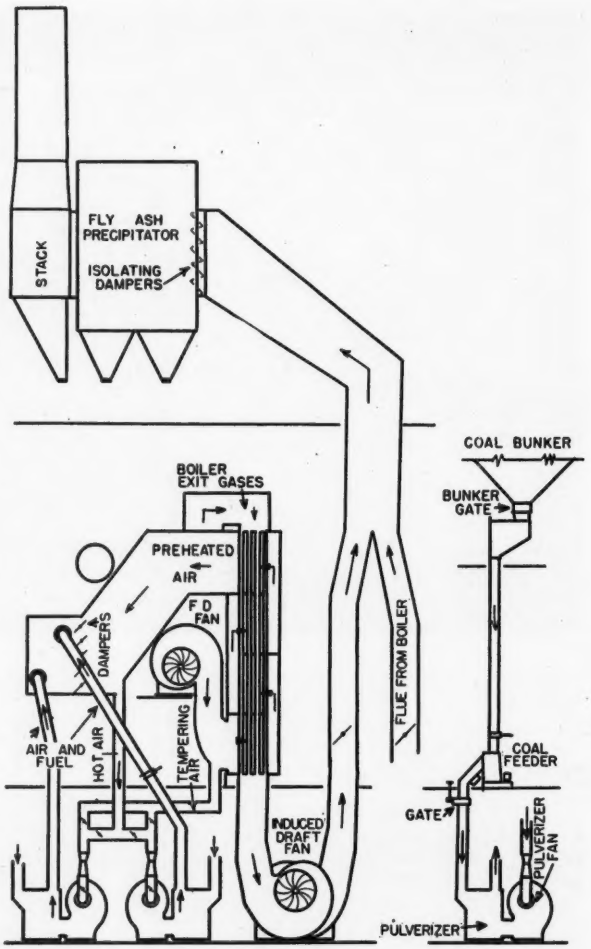


Fig. 3. Fuel and Gas Flow diagram.

As shown on the general plan, each of the new boilers is located in the space provided originally for two of the stoker fired boilers. The construction was complicated by the existence of the original building steel but outside of that no alterations to the present building were necessary.

An idea of the equipment involved in one of these boiler units may be obtained from the boiler fuel and gas flow diagram in Fig. 3. Coal from overhead bunkers is weighed by automatic electric scales and passes down through the coal feeders to the pulverizers. There are two pulverizers, one for each burner.

The two new boilers are Babcock & Wilcox integral furnace units, designed for 675 lb. per sq. in. each with an effective heating surface of 11,100 sq. ft. and with a nominal rated capacity of 1110 hp. Each unit has a guaranteed maximum 4 hr. capacity of 125,000 lb. of steam per hour and a guaranteed maximum continuous capacity of 100,000 lb. per hr. These capacities are based on feedwater at 390 deg., steam pressure 615 lb. gage and steam temperature leaving the boiler at from 840 to 850 deg. F. The total temperature at the superheater outlet is 843 deg. when operating at 100,000 lb. per hr.

Each furnace has a volume of 5900 cu. ft. The heat liberation in the furnace is 26,600 B.t.u. per cu. ft. per hr. at peak capacity. The overall boiler efficiency

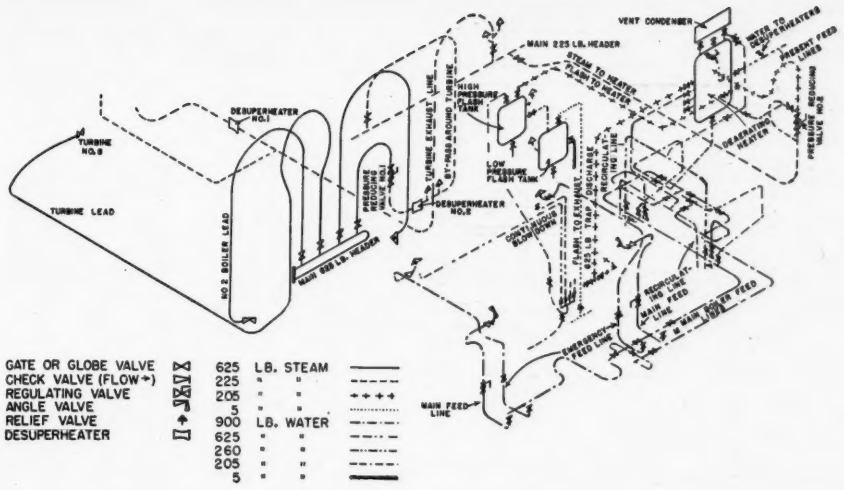


Fig. 4. Diagram of steam and water lines.

is guaranteed to be 86 per cent at 100,000 lb. of steam per hr.

The fuel upon which the design is based is Pennsylvania bituminous, 14,200 B.t.u. per lb. The ash softening temperature, 2575 deg. F. When generating 100,000 lb. of steam per hr. and with an efficiency of 86 per cent, the coal consumption is figured at 8710 lb. per hr.

The forced draft fans take air from the upper part of the boiler room and deliver to the air preheaters. Gases from the boiler exit are drawn downward through the air preheater by the induced draft fans below and then discharged upward to the electrostatic ash precipitators and thence into the stack.

Ash is removed from the furnace ash pits and fly ash from the hoppers below the air heaters, from the hoppers below the precipitator and from the hopper below the stack by a pneumatic conveyor system.

When ready to convey ash from any ash pit or hopper gate, a tumbler switch places in operation a mercoid switch on a "Flow Contactor" in the water supply to the air washer. When this water passes through the flow contactor the mercoid switch starts a motor operated steam valve which supplies steam to the exhauster thus creating the necessary suction to remove the ash or fly ash from the particular gate which is opened.

In the electric circuit for the motor operated steam valve for the exhauster is a timing switch to stop and start the flow of steam to the exhauster automatically. The action of the exhauster is then as follows: When the exhauster starts, the inrush of air closes a counterweighted gate on the bottom of the air receiver. After a fixed period of time the timer shuts off the motor operated steam valve, the exhauster effect is stopped and the weight of ash in the receiver causes the gate to dump the ashes to the storage tank. In a predetermined number of seconds as set by this timer, the motor circuit to the steam operated valve is again closed and the steam valve is opened and the exhauster again placed in operation. The intermittent starting and stopping will continue automatically as long as the tumbler switch is in the operating position at the station near the ash pit or hopper gate through which the ash or fly ash is to be removed.

The automatic stop and start operation of the motor operated steam valve for the exhauster does not, however, stop the flow of water to the air washer. When the ashes have been conveyed from any particular line, the gate is closed, the tumbler switch thrown to the off position, which automatically shuts down the exhauster. When the ashes have been removed from the ash pits and hoppers, the water to the air washers is shut off by hand and the ash separator water pump shut down.

Combustion Control

Combustion is controlled automatically by the Smoot-Republic combustion control system. This system operates on oil and air pressures from the present Smoot control power units for the stoker-fired boilers and which have been reconditioned to take care of the additional requirements.

A diagram of the principal elements of this combustion control system is shown in Fig. 6. It involves five important elements: the master controller, the air flow regulator, the furnace draft regulator, the fuel regulator and the fuel feed controllers. The latter are not a part of the Smoot equipment but they are mounted on the side of the Smoot boiler panels.

When the master controller is set for pressure control, the steam pressure is maintained practically constant, and acts through the master controller to regulate the air loading pressure controlling the action of

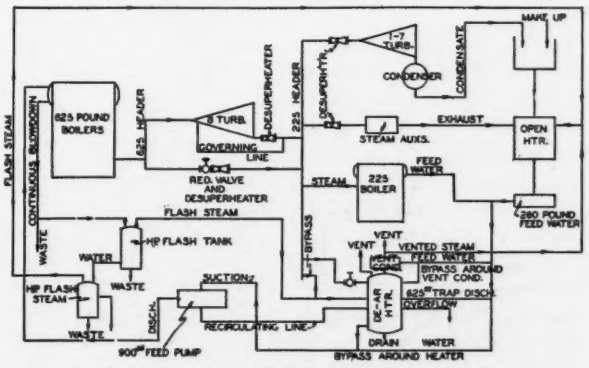


Fig. 5. Flow diagram.

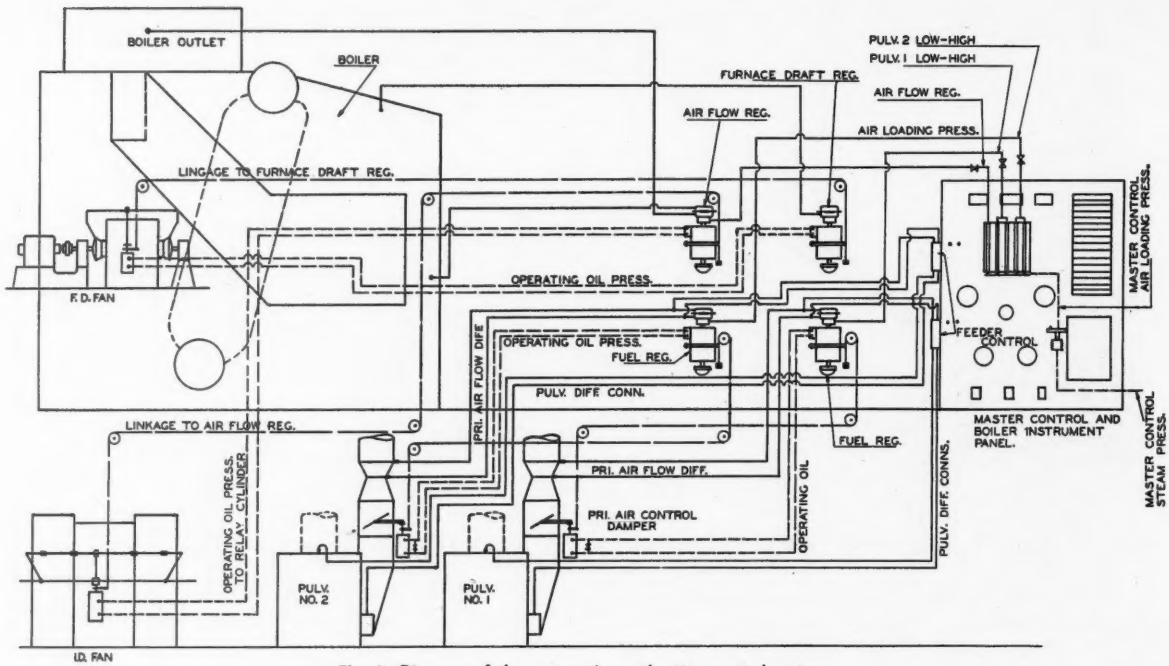


Fig. 6. Diagram of the automatic combustion control system.

the air flow regulator and the two fuel regulators for each boiler.

The air flow regulator operates by virtue of the pressure drop through the furnace and the action is controlled by the master air loading pressure to the master regulator, to adjust the opening of the vanes on the constant speed induced draft fan, to maintain the correct volume of gases passing through the combustion chamber. There is one air flow regulator for each boiler. It will be noted that the "boiler differential" connections on the two sides of the top diaphragm connect to the combustion chamber of the boiler at the center of the first pass and at the gas outlet of the boiler.

The furnace draft regulator operates to maintain the correct furnace or draft pressure and the action of the regulator is controlled by a weight loaded lever set to maintain the required furnace draft. This regulator is not connected to the master air loading pressures. Acting on the underside of the top diaphragm is the furnace draft (negative pressure). The top side of the diaphragm is balanced against the atmosphere. The connection to the combustion space of the boiler is above the center of the first pass of the boiler. The action of this regulator controls the opening of the vanes on the constant speed forced draft fan, thus controlling the quantity of air for the combustion of the pulverized coal.

Although this regulator is set to maintain a constant furnace draft and is not directly connected to the air loading chamber of the master controller, yet its action is indirectly controlled from this source through the action of the air flow regulator. This indirect action is started primarily by a steam pressure variation which causes a change in the air loading pressure, thus a reaction is transmitted to the air flow regulator which of course affects the furnace draft by controlling the flow of gas through the induced draft fan.

There is, therefore, an interrelated action between the air flow regulator operating the vanes of the induced draft fan and the furnace draft regulator which operates the vanes of the forced draft fan. There is one furnace draft regulator for each boiler.

The fuel regulators operate in response to the action of the master air loading and the air flow differential pressure in the primary air supply line to the pulverizers to maintain the correct position of the primary air control dampers. The quantity of pulverized coal fired depends upon the position of this primary air damper to each pulverizer, for the reason that the feeder controllers start and stop the coal feeders depending upon the quantity of primary air admitted to the pulverizers, and also upon the air pressure drop through the pulverizers. (The air pressure drop through the pulverizers connects only to the feeder controllers and not to any of the Smoot Regulators.) There are two fuel regulators for each boiler, one for each pulverizer and burner.

The connections for the fuel feeder controllers are shown in the diagram, Fig. 6, but are shown in greater detail in Fig. 7.

Feedwater Treatment

The feedwater pumping and heating system has already been briefly described and needs no further consideration here. A few words regarding the method of treating the feedwater will be of interest. The method of treatment includes treating the feedwater for the entire station by introducing the required chemicals in the low pressure feedwater heaters. This treatment is primarily for the needs of the 625 lb. boilers but incidentally conditions are so controlled as to maintain the 225 lb. boilers in equal or better condition than in the past. The elimination of dissolved oxygen in the feedwater to the 625 lb. boilers is, of course, accomplished by the use of the deaerat

(Continued on page 426)

Principal Equipment in the New Steel Point Extension

BOILERS—2 Babcock and Wilcox Co. Integral furnace, Type SP-22AH16 pulverized fuel fired boilers with water walls, superheaters and soot blowers. Boiler design pressure, 675 lb. per sq. in. Effective heating surface, 11,100 sq. ft. Nominal rated boiler capacity (from and at 212 deg. F.) each 1110 hp.

PULVERIZERS—B. & W. Type B, size 124, class 2218, 2 per furnace. Pulverizer motor, 40 hp. each, General Electric, 3 phase, 60 cycle, 2300 v., 1800 r.p.m.

PULVERIZER FANS—B. & W. Steel plate type primary air fan, one per pulverizer and each driven by the same motor that drives the pulverizer.

PULVERIZER FEEDERS—B. & W. Table Type, size 22½ in. one per pulverizer and each feeder driven by a ½ hp. General Electric motor, 3 phase, 60 cycle, 440 v.

BURNERS—B. & W. Type F.D. circular, one per pulverizer.

AIR HEATERS—B. & W. Tubular welded element type, one per boiler and each with four air passes over element surface, each 10,320 sq. ft.

SUPERHEATERS—B. & W. Loop type, 6 loops.

SOOT BLOWERS—Diamond. Furnished and installed by B. & W. Co. 2 sets (1 per boiler) valve-in-head type. Soot blower system arranged to use saturated steam. Each boiler is also equipped with one special floor blowing soot blower.

FORCED DRAFT FANS—B. F. Sturtevant Co. 2 No. 85, design 8 D.W.D.I. with vane control, one for each boiler and each fan driven by a General Electric Co. 75 hp., 3 phase, 60 cycle, 2200 v., 1750 r.p.m. motor. Fan capacity: Volume, cu. ft. per min., 35,400.

Volume-pressure control: by use of Smoot Automatic Control of vanes and with fans operated at constant speed.

INDUCED DRAFT FANS—B. F. Sturtevant Co. 2 No. 1004, T.V.I.D. Design 2, with vane control, one for each boiler and each fan driven by a General Electric Co., 125 hp., 3 phase, 60 cycle, 2200 v., 870 r.p.m. motor. Fan capacity: Volume, cu. ft. per min., 72,500.

TURBINE-GENERATOR—General Electric Co.

1—5000 kw. non-condensing Turbine-generator set with direct connected exciter.

Generator. 6250 kv-a. 80 per cent power factor, 5000 kw., 3600 r.p.m., 2 poles, 3 phase, 60 cycles, 6900 v., 523 amp. "Y" connected.

Turbine. Initial steam pressure 600 lb. ga. steam temperature 740 to 840 deg. F.

Exciter. 40 kw., 3600 r.p.m., d.c., 125 v., 320 amp. compound wound.

Surface air cooler. 2 main sections using sea water for cooling.

BOILER FEED PUMPS—Ingersoll-Rand Co. 2—No. 3 Type H.M.T. Cameron, 5 stage central station type pumps capacity, 254,000 lb. per hr. each direct connected through a flexible coupling and driven by a General Electric Co., 250 hp., Type FT, 3 phase, 60 cycle, 2200 v., 3600 r.p.m. Induction motor.

DEAERATING FEEDWATER HEATER—Elliott Co. 1 high pressure deaerating feedwater heater with accessories. Type, Vertical shell with vent condenser mounted above. Design pressure, 250 lb. per sq. in. Volume 119 cu. ft. water storage below deaerating section. Vent condenser, 40 sq. ft. of active condensing service containing 66—1 in. O.D. tubes having an overall length of 30 in. each. Capacity, 250,000 lb. per hr., from 210 to 390 deg. F.

COMBUSTION CONTROL EQUIPMENT—Smoot, Republic Flow Meters Co. The combustion control equipment for the two pulverized fuel fired boilers include:

2 Boiler Master Controllers (one for each boiler) each consisting of 1 automatic compensator, 1 Semi-automatic control element, 1 Throw over device, 1 Mercury gage element, 1 Set of ratio valves, 1 Rating control valve, 4 Fuel Feed regulators, 2 Air flow regulators, 2 Furnace draft regulators.

INSTRUMENTS—Republic Flow Meters Co.

2 Republic multi-point indicators, 2 Republic six pen continuous strip chart recorders, 2 Republic Type "AR" meter bodies for boiler and steam flow record and indications, and orifice plates and holders for welding into the boiler leads.

The Republic Meters furnished and mounted on the turbine panel include: 1 Circular chart recorder to record steam flow to turbine, 1 Steam flow to turbine, 1 Steam flow integrator to integrate steam flow to turbine, 1 Meter body and orifice and reservoir, 1 Two pen Circular Chart. Turbine steam and exhaust pressures.

The following instruments are mounted on the feed water panel: 1 Circular Chart Recorder to record feed water flow from feed pumps, 1 Watt-hour type integrator to totalize feed water flow, 1 Two pen circular chart recorder to record F.W. temp., 1 Two pen circular chart recorder to record the discharge pressure from B.F. pumps.

DESUPERHEATERS AND PRESSURE REDUCING VALVES—Smoot-Republic.

Desuperheater No. 1 Straight line venturi type size 14 by 14 in. to maintain exhaust temperature of the steam from the 5000 kw. turbine, within plus or minus 5 deg. of 620 deg. F.

Desuperheater No. 2. Smoot straight line type 10 by 10 in. for the high pressure by-pass around the 5000 kw. turbine.

Desuperheaters Nos. 3 and 4. Size 12 by 12 in. Smoot straight line venturi type for maintaining an exit temp. plus or minus 5 deg. of 515 deg. F. in the leads to No. 1 and No. 2 10,000 kw. turbines.

Desuperheaters Nos. 5 and 6. Size 8 by 8 in. Smoot straight line venturi type in the lines to the auxiliary headers.

PRESSURE REDUCING VALVES

No. 1, 6 in. Smoot turbine type reducing valve for steam by-pass around the 5000 kw. turbine.

No. 2, 6 in. Smoot Butterfly type to reduce and hold the steam pressure to the deaerator constant.

FEEDWATER REGULATORS—Republic Flow Meters Co.

2 Turbine type regulating valves, one for each boiler, together with boiler level regulators.

GENERATOR AIR COOLER AND OIL COOLER PUMP—Pennsylvania Pump and Compressor Co. 1—3 in. B.M.D., Single stage centrifugal pump driven by 10 hp. General Electric 1800 r.p.m., 3 phase, 60 cycle, 440 v. motor.

AIR COMPRESSOR FOR DESUPERHEATER CONTROL—Quincy Compressor Co.—1 Model FA-27 Duplex Single Cylinder Single Stage Automatic Air Compressor unit with General Electric 5 hp., 3 phase, 60 cycle, 440 v. motor and starter. Unit complete with 20 by 60 in. A.S.M.E. Air receiver.

ASH SEPARATOR WATER PUMP—Pennsylvania Pump and Compressor Co. 1—1½ in. B.M.D. single stage double suction pump driven by a 5 hp. General Electric Co. 3 phase, 60 cycle, 440 v., 1800 r.p.m. Type K motor, with across the line starter. Capacity, 60 g.p.m. of 80 deg. fresh water against 140 ft. total dynamic head.

RETURN WATER PUMP FROM TURBINE PACKING SEAL CONDENSERS—Pennsylvania Pump and Compressor Co. 1—1½ in. B.M.D. single stage double suction pump driven by a 5 hp. General Electric Co. 3 phase, 60 cycle, 440 v., 1800 r.p.m., Type K motor with across the line starter. Capacity, 50 g.p.m. of 90 deg. to 150 deg. condensate against 130 ft. total dynamic head.

COTRELL ELECTRICAL PRECIPITATION EQUIPMENT—Research Corp.

1—Precipitator of 2 units. Rated capacity, 93,000 cu. ft. of normal gas per minute at 400 deg. F. gas entering temperature.

ASH AND FLY ASH HANDLING EQUIPMENT—United Conveyor Corp.

DISCHARGES FOR PRECIPITATOR HOPPERS

4—Complete vibrating dischargers with ¼ hp. motors.

ASH STORAGE TANK—Net storage capacity, 62 tons.

COAL SALES—Richardson Scale Co. 4—movable enclosed type apron feed automatic coal scales (2 per boiler). Capacity, 200 lb. and each capable of weighing 8 tons per hr. of crushed coal. Guaranteed accuracy ½ of 1 per cent true weight. Each scale is operated by ½ hp. motor.

COAL BUNKER GATES—Gifford Wood Co. 8—20 by 20 in. low body duplex gates, cut-off type.

COAL CONVEYOR EXTENSION—Link Belt Co. Extending conveyors C-1 and C-2 including "Cleveland" worm gear reducers, "Poole" flexible couplings for high and low speed shafts and 2—10 hp. General Electric motors.

CHEMICAL SOLUTION PUMP—Worthington Pump & Machinery Co. 1 size 1 by 2 in. Horizontal duplex power pump with General Electric ¾ hp. motor. Pump capacity 2.5 g.p.m. of solution at 125 ft. total dynamic head.

STEEL STACK AND BREECHING—Connery Construction Co. This includes breeching above roof line connecting to steel plate work by Babcock & Wilcox Co. from 2 boiler units and connecting to and from the Cottrell precipitator above the roof.

CONTINUOUS BLOW-DOWN EQUIPMENT—Cochrane Corp.

1 High Pressure flash tank—W.P. 250 lb.

1 Low Pressure flash tank—W.P. 50 lb.

VALVES. Forged Steel Valves up to 2 in. Edward Valve & Mfg. Co.

Superheat Control

Among the problems which demand increased attention as the technique of power generation advances, none is more important than the control of superheat, or more correctly total steam temperature, within narrow limits. Physical properties of metals used set an upper limit which cannot be exceeded with safety. Economics demand that the temperature be maintained as close as possible to this limit over the working range of the boiler so that expensive alloy equipment be used to advantage at all times. The natural characteristic of the superheater is far from ideal and the engineer is faced with the problem rectifying its limitations by external means. The problem first received attention in connection with the reheat cycle and is now one of the major problems of the high temperature cycle. Many schemes have been used, the popular trend at present being toward dampers for regulating the gas flow over the superheater sections.

By R. Stark-von Rogar

ALTHOUGH INTIMATELY RELATED to, and forming an integral part of, the requirement for superheat control, space does not permit a discussion of the thermal characteristics and requirements of turbine. Engineers are now familiar with the economics underlying the selection of high temperatures and pressures for both topping and regular turbine installations and with the current choice of the once through in preference to the reheat cycle. For this reason, this article continues from the generally accepted premises that the modern turbine requires steam at a constant temperature over a considerable range of steam flow if it is to operate at its optimum efficiency, and that, the temperature must be kept below a definite maximum to protect the equipment involved.

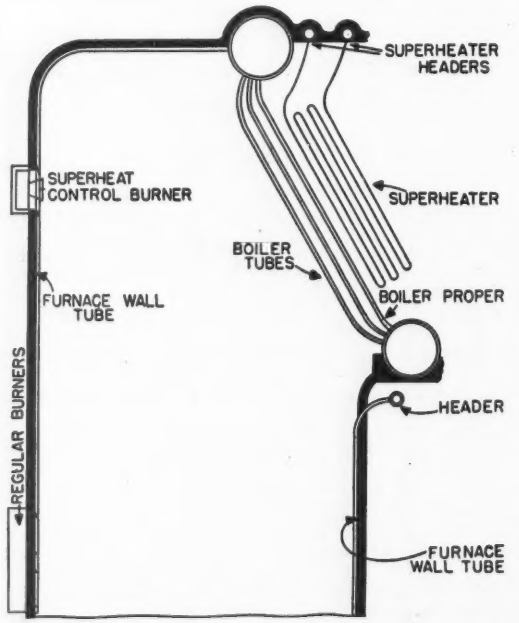


Fig. 1. Control of superheat by an auxiliary burner directly opposite the superheater is one method of temperature control. A superheat burner will be used on the 750,000 lb. per hr., 1250 lb. 925 deg. F. wet bottom boiler at Windsor station. The other boiler of the same size will have a split furnace and combination superheaters

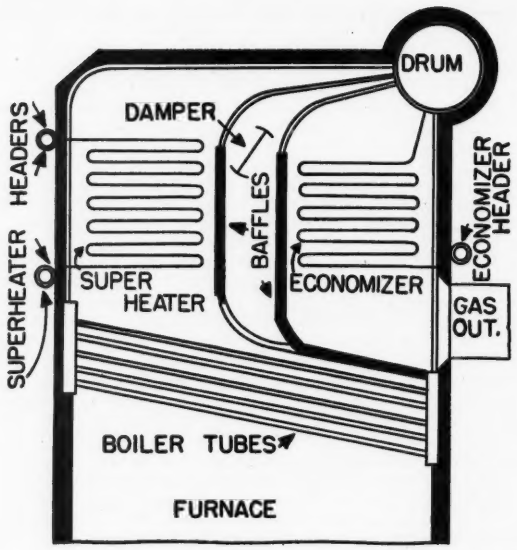


Fig. 2. The modern trend in steam temperature control is toward dampers. This shows an application to a straight tube boiler baffled for two passes. Note the water cooled baffles

With this as a prerequisite, up to date steam generating units have been arranged in a variety of designs to provide superheat control, or, in other words, to maintain a flat superheat vs. steam flow curve over a wide range of boiler rating. The principal methods of controlling the total steam temperature are listed below, without regard for the extent of their application or effectiveness, and each is discussed briefly in the following paragraphs:

A. Combination of radiant and convection superheaters.
B. Single superheater and desuperheater.
C. Two-stage superheater with desuperheater between stages.
D. Superheat control burner.
E. Baffles and dampers.

Superheat control obtaining from the use of a convection type superheater in the boiler bank in series with a radiant type in the furnace depends upon the inherent characteristics of the two types for the desired results. Referring back to the elementary principles of heat transfer, it will be remembered that the temperature curve of a convection superheater rises with increasing steam flow or heat input to the furnace, while that of the radiant type falls under similar conditions. By combining a properly proportioned superheater of each type, a flat curve can be obtained, the two superheaters compensating under load changes to produce a constant total steam temperature.

When temperatures are such that the tubes of the radiant superheater would approach dangerously high values when subjected to the output of the convection superheater the former is placed first in the series. Sometimes, however, it is not possible to obtain the mass flow necessary to prevent overheating and in these cases alloy steel tubes are used.

It might also be mentioned here that in certain

arrangements of boiler and furnace a superheater placed behind a screen of boiler tubes will possess to some extent the characteristics of both the radiant and convection types and produce a fairly flat curve.

Desuperheaters

In describing the next two methods, B and C, it may be said that there are many engineers who regard the desuperheater as a thing of the past, but, as there is at least one American installation using a single superheater and a desuperheater in series planned for this year the method seems worthy of a brief comment. The design and operating principles are quite simple, the boiler, convection superheater and desuperheater are connected in series with a valve at the desuperheater arranged to permit a certain portion of the steam to be passed over the cooling surface. The superheater is designed to give the desired steam temperature at the minimum plant load and no steam passes through the desuperheater at this rating. As the steam flow, and likewise the total steam temperature from the superheater, increases, a portion of the flow is diverted through the desuperheater and remixed with the balance to provide the desired mean temperature at the desuperheater outlet.

This system fulfills the requirements of a control arrangement in that it limits the total steam temperature to the desired degree and provides a flat temperature vs. quantity curve. It is not likely to be found on extremely high temperature installations, however, inasmuch as the superheater tubes are subjected to the highest temperature produced by the furnace conditions regardless of the desired final temperature.

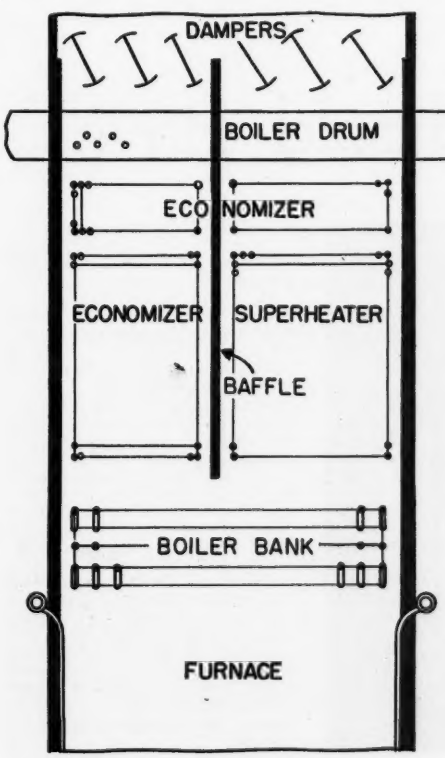
When this condition would result in unsafe tube temperatures a two-stage superheater with the desuperheater between stages may be employed. The amount of desuperheating is increased with increasing rating so that the temperature of the output from the second stage of the superheater will be constant. By this means the final tubes of the superheater are maintained far below the temperature they would reach if the same heating surface were built as a single stage. There are a number of installations of this type in Europe and the method has also been applied in America.

Desuperheaters used in both the single and two-stage methods are conventional types such as the convection and contact varieties which may be considered analogous to surface and jet condensers respectively. The cooling water is usually obtained from the boiler drum and the saturated steam produced in cooling the superheated steam is returned to the drum.*

Separate Burner

Controlling steam temperature by means of a separate superheat control burner, D, comprises placing this burner at some point in the furnace considerably closer to the boiler entrance than the regular burners, as illustrated schematically by Fig. 1. When the load on the boiler is reduced the heat input to the superheat control burner is increased and that to the regular burners is, of course, reduced in accordance with the steam flow requirement. As the combustion gases from this burner are far less effected by the cooling effect of the furnace than those from the regular burners, they reach the superheater at a higher temperature. By balancing the input to the control and regular burners the temperature of the gases entering the boiler may be maintained

*Ed. Note. The desuperheater used for temperature control at Lynn Station is built in the drum. The construction and control is shown in the article "Lynn Gas & Elec. Co. Adds Pulverized Fuel Boiler Unit" by Figs. 8 and 10 on pages 331 and 332 of the June issue of Power Plant Engineering. A similar arrangement used in a new Dutch station is described on page 401 of this issue.



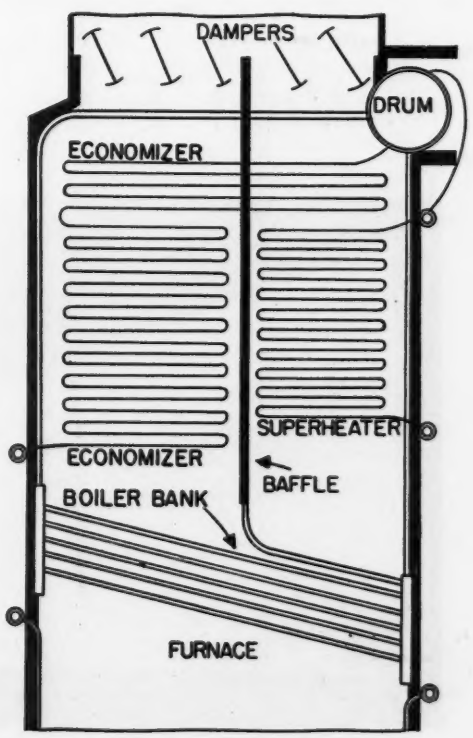


Fig. 3. In the single pass straight tube type of boiler the baffles may be either parallel or perpendicular to the drum. The dampers in either case are at the boiler outlet so that only comparatively cool gasses pass over them

such that the steam temperature will be constant regardless of boiler rating.

Use of gas baffles and dampers, E, for controlling steam temperature is finding extended application in this country. Although many variations in the mechanical design are extant the operating principle is the same in all and consists of bypassing some of the combustion gases around the superheater at high ratings. The amount of gas so bypassed is controlled by dampers usually placed at the boiler exit where the gases are relatively cool and the damper mechanisms not subjected to damaging temperatures. In many arrangements all the gases may be diverted around the superheater to protect it when bringing a boiler on the line rapidly. The superheaters are generally designed to give the desired total steam temperature at 50 or 60 per cent load with all the gases passing over the superheater surface. As the load rises the dampers are moved to pass increasing amounts of gas around the superheater.

By proper manipulation of the dampers the following gas flow conditions may be obtained:

1. No gas flow over superheater by closing the dampers over the superheater. Used this way for starting.
2. All gas flows over the superheater by opening the dampers over the superheater and closing those over the economizer. Used this way for low (50-60 per cent) load operation.
3. Part of gas flows over the superheater by opening both sets of dampers varying amounts. Used this way for high rating operation.

In straight tube boilers of the single gas pass type the baffling may be either parallel or perpendicular to the drum, as shown by Fig. 3, extending the full dimension of the casing to divide the upper part of the boiler housing into two sections. Superheater surface occupies one section and economizer surface the other, as indicated in the drawings and there is often some economizer surface at the top of both sections to take care of the comparatively high gas temperatures leaving the superheater. The dampers are located at the boiler outlet where the gases are sufficiently cool to permit the operation of a suitable control mechanism. The baffles are water cooled and supported by tubes from the downtake header of the convection boiler bank.

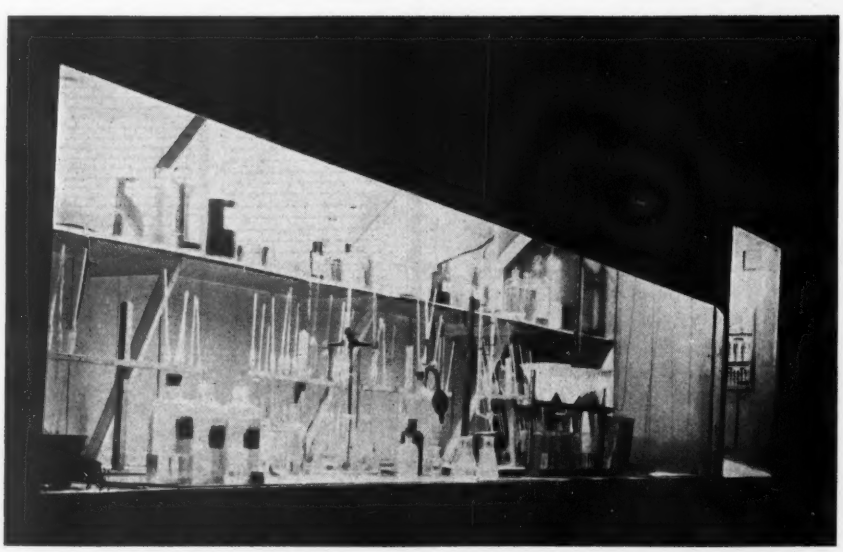
A somewhat similar arrangement sometimes used in connection with straight tube twopass boilers is shown by Fig. 2. In this construction two parallel baffles extending the full width of the setting provide a short-circuiting passage for conducting some of the gas around the superheater at high ratings. A damper at the top of the passage is closed when all the gases are required to flow over the superheater.

In bent tube boilers the bypass baffle may be set perpendicular to the drums and form a lane with the side of the boiler casing, or, two parallel baffles perpendicular to the drums may form a lane through the center of the boiler. Additional baffles may be used to govern the gas flow, but these in no way affect the control method, but in neither case does the superheater surface extend into the lane formed by the baffle or baffles.

Operation

Consequently by regulating the portion of the gas passing through the lane the amount flowing over the superheater surface is varied with the desired effect on the steam temperature. Dampers located at a cool point in the system regulate this division of the gases. This very general discussion does, it is believed, cover the principal methods of temperature control and, in subsequent articles, the design and operating features as applied to specific installations, will be described in detail.

What Every Plant Should Have



Running a modern power plant efficiently without instruments would be an impossible task, yet it is relatively simple compared to maintaining proper feedwater conditions without at least a simple laboratory. Many plants try to do it, however, and then wonder why scale, corrosion, foaming and priming are prevalent.

The laboratory need not be elaborate and carefully arranged kits are available on the market for as low as $10. The one shown above is an unusually fine one because A. H. Peterson, Supt. of Power of the Kalamazoo Vegetable Parchment Paper Co. of Kalamazoo, Mich., believes that if a thing is worth while doing at all it is worth doing well. This laboratory in one corner of the boiler room is convenient, well arranged, well lighted, and fully up to the standard set by the rest of the plant, which although not the newest in the district, is second to none in the country as far as operation, maintenance and housekeeping is concerned.

Solid CO_2 from Flue Gas

New process effective for recovering CO_2 at low concentrations

PROMISING to make every smoking chimney in America a potential commercial source of "dry ice," a new chemical process was described at the ninety-third meeting of the American Chemical Society at Chapel Hill, N. C., by J. Wellford Martin and D. H. Killeffer, chemical engineers of New York City. The new method utilizes ammonia gas to speed up chemical reactions in giant absorption towers where flue gas is passed through a lye solution for the recovery of carbon dioxide. Because of the relatively low recovery even from especially controlled coke fires, the cost of independent production has been high, and supplies needed for making the solid CO_2 have been largely drawn from by-product sources seldom ideally located with respect to consuming markets.

Possibilities opened by cheap production of pure carbon dioxide from flue gases of plants operated for power production are especially important in the dry ice industry, where supplies are needed at consuming markets to avoid losses in handling and shipping this important refrigerant. Already its practical economy has been shown, and where off-peak power at low prices is available, it is probable that it may be able to compete successfully with present production from by-product gas.

Devised by Professor Ralph H. McKee of Columbia University and Ernest A. Winter, a research student, the new absorption procedure is said to overcome the defects of the alkali carbonate absorption to a remarkable degree at very low cost without introducing odor or flavor into the purified gas. In principle the process consists of combining the carbon dioxide in the gas phase with ammonia in the presence of water vapor. This reaction, which occurs in the partly stripped flue gas, converts carbon dioxide, which is soluble only with difficulty, into carbonate of ammonia, which is readily soluble in alkali carbonate solution. In this way the capacity of the absorbing system may be actually doubled and the concentration of carbon dioxide in the exit gas reduced to as little as a fraction of one per cent. The preferred temperature is 130 degrees Fahrenheit.

The absorber system is similar to those now in use. It consists of packed towers down which lye trickles countercurrent to the flow of flue gas. Ordinary absorption towers are packed with coke, but experience has shown that steel turnings sifted free of particles under a quarter of an inch are superior to coke. Bubble plate towers also have high efficiency, but the higher cost of their construction, as well as their higher back pressure in operation, have militated against their general adoption.

Ammonia present in the gas phase in the tower apparently acts in the manner of a catalyst in carrying the carbon dioxide into the lye solution. As ammonium carbonate is formed it is dissolved in the lye, whose alkalinity decomposes it, freeing ammonia to re-enter the vapor phase reaction zone. This cycle process continuously repeats itself.

Boiling off of the carbon dioxide from the charged lye is conducted in the ordinary manner. Water condensed from the cooled pure gas contains ammonia and is returned to the top of the absorber with the cooled spent lye. Because the lye is brought to a higher carbon dioxide content in the absorbers, the amount of steam required for operating the lye boiler per pound of evolved gas is slightly lower than in standard practice.

A small amount of ammonia remains in the lye after the absorption to be evolved with the carbon dioxide in the lye boiler at the higher temperature met there. Reaction in the lye boiler also involves a rather copious evolution of steam along with the carbon dioxide, however, and before compression of the gas, most of this steam is condensed, carrying with it the greater part of the ammonia, with some carbon dioxide, in solution.

This condensate, which removes all but traces of ammonia from the carbon dioxide, is returned to the top of the second absorption tower, where it serves to wash the final exit gas practically free from ammonia and return it to the system. There is a slight loss of ammonia from the system with the waste gas, but this loss is so slight, 2 lb. per t. of carbon dioxide output, that it has so far been uneconomical to attempt its complete recovery.

Improved Steam Boilers at a Dutch Power Station

FOUR BABCOCK & WILCOX water-tube boilers have recently been put into commission at the power station at Nijmegen, Holland, of the Gelderland Electric Power Co. They are each designed for a maximum continuous rating of 226,400 lb. of steam per hour at 565 lb. per sq. in. and a temperature of 842 deg. F. The units comprise B. & W. Style 28 stokers, twin 27 ft. by 24 ft., Bailey furnaces, fusion-welded boiler drums, flash-welded economizers and two superheaters per boiler in series with an "attemperator." The arrangement of the superheaters and the attemperator is claimed to result in a very close regulation of the final steam temperature. The attemperator consists of a number of U tubes through which part of the steam is passed; the tubes are immersed in water taken from the boiler drum and the steam generated is taken back to the drum. The proportion of the steam passing through the U tubes is governed by a directing valve, movement of which is controlled by a thermostat placed in the steam pipe immediately in front of the boiler stop valve. The effect of the arrangement is that any increase in temperature of the outlet steam beyond a predetermined figure causes the directing valve to close against the main steam flow and to pass a greater proportion of the steam through the cooling tubes; a fall in temperature has the opposite effect.

TURBINE WATER RATES Are Not Mysterious

Some curves and a little fundamental theory simplify calculations and heat balance layouts

By G. R. PROBST

Moore Steam Turbine Corp.,
Wellsville, N. Y.

BY THE USE of the Mollier diagram,* or heat-entropy chart, and turbine efficiency curves it is possible to calculate with reasonable accuracy the expected steam consumption of various types of steam turbines. This article outlines a simple method which will give approximate steam consumption, power available from a given quantity of steam, and quality of exhaust or bled steam from the average commercial steam turbine. The efficiency curves used are for steam turbines which sell at average market prices. It must be borne in mind that turbines having higher steam consumption at a lower price, and turbines having lower steam consumption at a higher price are also available.

Primarily the efficiency of any steam turbine depends upon the nozzle and bucket efficiency which is a function of the velocity of the turbine wheel divided by the steam velocity from the nozzles. The wheel velocity is of course dependent on the diameter and the speed. Steam velocity is governed by the heat drop or B.t.u. available between inlet steam pressure and exhaust pressure.

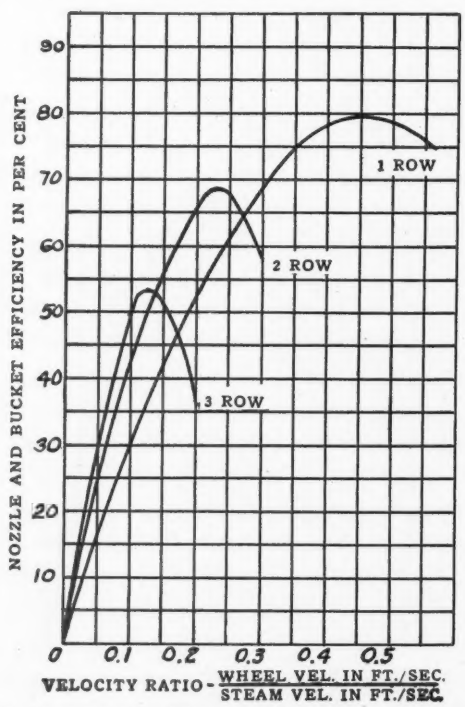


Fig. 1. Nozzle and bucket efficiencies depend upon the design of wheel and the velocity ratio

Figure 1 shows how the nozzle and bucket efficiency of various types of impulse turbine stages vary with the ratio of the wheel velocity to the steam velocity. These curves clearly indicates that it is desirable, in order to secure highest efficiency, to operate within a certain range of ratio to secure the highest efficiency. When the ratio is too low the velocity of the steam is too great for the wheel velocity and the efficiency decreases, whereas if the ratio is too high the wheel velocity is too great for the steam velocity, and the efficiency also decreases.

Small single stage turbines for direct connection to equipment such as pumps, fans, blowers, etc., usually run at speeds between 1000 and 4000 r.p.m. In this range the efficiency is not at the peak as the wheel diameter of the turbine is small, and the ratio of the wheel velocity to the steam velocity is low. For any given speed the wheel diameter can of course be increased, and theoretically, the steam consumption reduced.

This is not always advisable, especially in small horsepowers, as an increase in the wheel diameter increases the cost of the turbine, and the windage loss, which increases as the fifth power of the diameter, can readily overcome any gain in nozzle and bucket efficiency. In multi-stage turbines it is possible, by increasing the number of stages, to operate at conservative speeds with relatively small wheel diameters and still maintain high efficiencies. By means of reduction gearing single stage and multi-stage turbines may be operated at their most efficient speed. In regular commercial practice the exhaust steam from small turbines is

*Mollier Diagrams will be found in all steam tables and most books on thermodynamics. A large size chart on heavy paper covering a range of up to 1000 deg. F. and up to the critical pressure may be obtained from the American Society of Mechanical Engineers, 29 W. 39th Street, N. Y. City, for 35 cents per copy.

practically always used for process or heating so that high efficiency and low steam consumption are not always of prime importance.

Symbols

Practical turbine problems occur in many forms and in the following paragraphs a number of typical examples are worked.

The following symbols will be used:

P_o = Initial pressure in lb. per sq. in. abs. = initial gauge pressure + 15.

P_f = Exhaust pressure in lb. per sq. in. abs. For noncondensing operation this equals the gauge exhaust pressure + 15. For condensing it equals ½ (30 — exhaust vacuum in inches of mercury).

D_o = Initial superheat in deg. F., or, quality in percent, i. e., 100 minus percent moisture.

D_f = Final superheat in deg. F., or, quality in percent, i. e., 100 minus percent moisture.

H_o = Initial total heat in B.t.u. per lb.

H_1 = Final total heat in the turbine exhaust in B.t.u. per lb.

H_f = Final total heat in B.t.u. per lb. after adiabatic expansion (theoretical for a turbine with 100 percent efficiency).

Lb. = Pounds.

Flow = Pounds per hour of steam.

Eff. = Efficiency.

Hp. = Horsepower.

R.p.m. = Revolutions per minute.

W.R. = Water rate or steam consumption in lb. per hp-hr.

Steam consumption in pounds per kw-hr. equals:

$$\frac{\text{W. R.} \times 1.34}{\text{Generator Efficiency}}$$

Steam Conditions: First figure refers to initial pressure in lb. per sq. in. gauge; second figure to superheat in deg. F. (or per cent moisture when so marked); third figure to exhaust pressure in lb. per sq. in. gauge (as 15 lb.) or inches of vacuum (as 27 in.). Thus, in example 1, steam conditions have been assumed and are given as, 385 lb.—60 deg. F.—20 lb. which should be read as 385 lb. ga., 60 deg. F. superheat and 20 lb. ga. back pressure.

The first step in finding the steam consumption of any turbine is to find, from the Mollier Diagram, the heat drop available. To do this we must know the initial steam pressure available, the superheat or quality of the steam and the pressure against which the turbine will exhaust.

For H_o, locate, on the Mollier diagram, the intersection of the line of constant pressure corresponding to the initial absolute pressure of 400 lb. and the line of constant superheat in this case 60 deg. The initial total heat H_o read at this point is 1247 B.t.u. For H_f, follow vertically downward from the intersection found above to the line of constant pressure corresponding to the absolute exhaust pressure of 35 lb. (20 + 15) is reached. At this point the final total heat H_f is found to be 1056 B.t.u. By subtracting H_f from H_o the available heat is found to be 191 B.t.u. This is the heat energy which is theoretically available in each pound of steam for conversion into useful work.

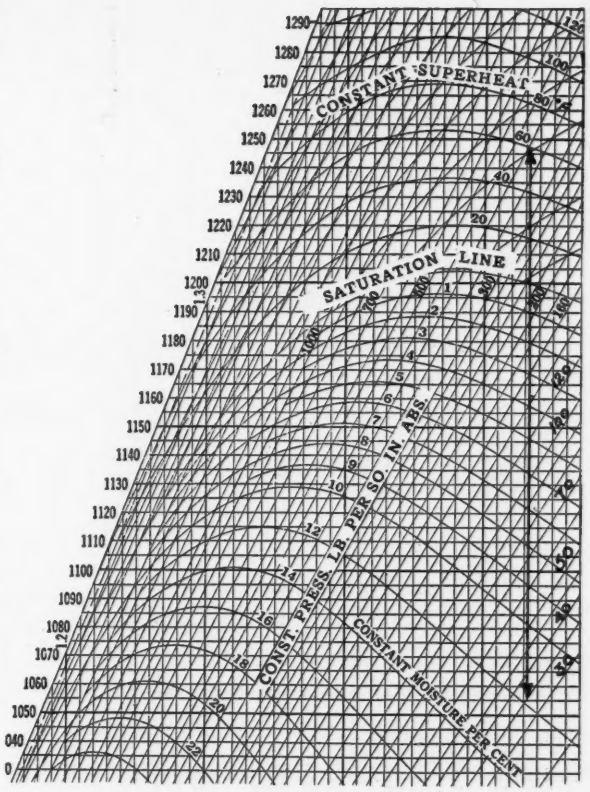


Fig. 2. The Mollier diagram is the working tool of the turbine engineer. This figure indicates the initial steps to be taken in solving Example 1. The heavy arrow indicates the available heat drop.

Figure 3 shows the efficiencies of single stage noncondensing turbines while Figs. 5 and 6 show efficiencies of multi-stage condensing and non-condensing multi-stage turbines respectively. The following examples will explain the use of the Mollier diagram and the efficiency curves as applied to commercial turbines.

To Find the W. R.

Example 1: Find the W. R. of a single-stage 60 hp., 2500 r.p.m., non-condensing turbine. Steam conditions: 385 lb.—60 deg. F.—20 lb.

A. Find H_o. $P_o = 385 + 15 = 400$ lb.; $D_o = 60$ deg. F.; and from the Mollier diagram $H_o = 1247$ B.t.u.

B. Find H_f. $P_f = 20 + 15 = 35$ lb.; and from the Mollier diagram $H_f = 1056$ B.t.u.

C. Find $(H_o - H_f) = 1247 - 1056 = 191$ B.t.u.

D. From desired hp. = 60 and r.p.m. = 2500 find Eff. from Fig. 3 as 20 per cent or as a fraction 0.20.

E. Calculate from the following equation, the W.R. which is equal to

$$\frac{2545}{(H_o - H_f) \times \text{Eff.}}$$

Substituting the proper values

$$\frac{2545}{191 \times 0.20}$$

This gives a W. R. of 66.5 lb. of steam per hp-hr.

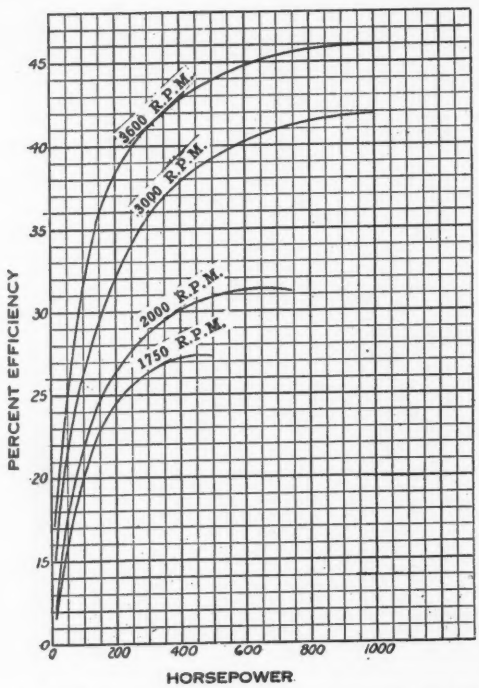


Fig. 3. Efficiency curves for single stage non-condensing turbines

To Find the W. R. for Condensing Operation

Example 2: Find the W. R. of a multi-stage 620 hp., 3500 r.p.m. condensing turbine. Steam conditions: 400 lb. — 150 deg. F. — 28 in.

A. Find H_o. $P_o = 400 + 15 = 415$ lb.; $D_o = 150$ deg. F.; and from the Mollier diagram $H_o = 1303$.

B. Find H_f. $P_f = \frac{1}{2}(30 - 28) = 1$ lb.; and from the Mollier diagram $H_f = 885$ B.t.u.

C. Find $(H_o - H_f) = 1303 - 885 = 418$ B.t.u.

D. From the desired HP = 620 and r.p.m. = 3500 the Eff. from Fig. 5 is 63.5 per cent, or expressed as a fraction 0.635.

E. W. R. can then be calculated as an Example 1, and is

$$\frac{2545}{418 \times 0.635}$$

which is equal to 9.58 lb. of steam per hp-hr.

Calculations for the next example are similar but the conditions have been changed to a multi-stage turbine, operating condensing. Efficiency curves of Fig. 5 are used instead of those of Fig. 3.

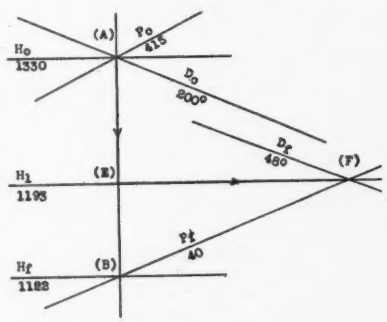


Fig. 4A. Illustrating the solution of Example 3. The steps are also shown on the Mollier Diagram Fig. 4 by black arrows

To Find the Condition of Exhaust Steam

Example 3: Find the superheat or quality of exhaust steam from an 840 hp., 3400 r.p.m., multi-stage turbine. Steam conditions: 385 lb. — 200 deg. F. — 25 lb.

A. Find H_o. $P_o = 385 + 15 = 400$ lb.; $D_o = 200$ deg. F and from the Mollier diagram $H_o = 1332$ B.t.u.

B. Find H_f. $P_f = 25 + 15 = 40$ lb. and from the Mollier diagram $H_f = 1122$ B.t.u.

C. Find $(H_o - H_f) = 1332 - 1122 = 210$ B.t.u.

D. From rated HP. = 840 and r.p.m. = 3400, the Eff. from Fig. 6 is 66.0 per cent, or as a fraction, 0.660.

E. Find $H_1 = H_o - \text{Eff.} \times (H_o - H_f) = 1332 - (0.660 \times 210) = 1193$ B.t.u. per lb. of steam.

F. Locate intersection of horizontal line corresponding to H_1 and "line of constant pressure" corresponding to $P_f = 40$. Read D_f at this point as 48 deg. F. of superheat.

These three examples are typical of the everyday needs of engineers. The convenience of being able to calculate water rates of turbine drives for auxiliaries and power equipment are too obvious to need further comment. Example 3 is particularly useful for industrial engineers interested in the temperature or quality of the exhaust steam for process use. Although specific steam conditions and turbine types have been assumed, these may be changed to any desired conditions and the calculations followed through in the same way, using the proper efficiency curves.

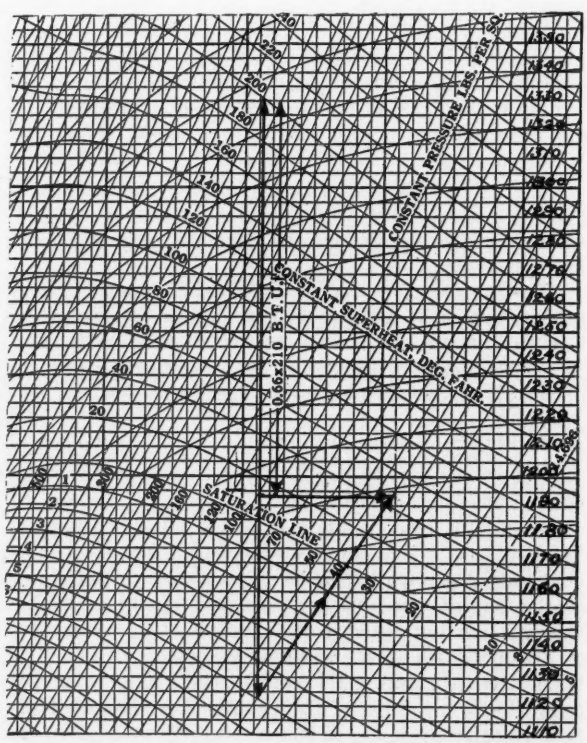


Fig. 4. Illustrating the solution of Example 3 on the Mollier diagram

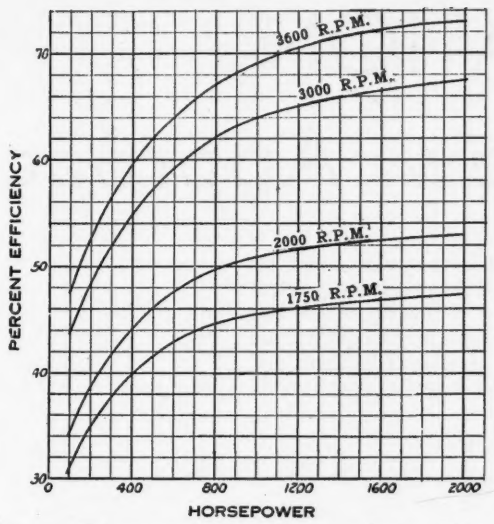


Fig. 5. Efficiency curves for multi-stage condensing turbines

To Find the Power Available From Low Pressure Steam

Example 4: Find power available from 18,000 lb. per hr. of low pressure steam when used in a 3600 r.p.m. multi-stage condensing turbine. Steam conditions: 3 lb. — saturated — 28 in.

A. Find H_o. $P_o = 3 + 15 = 18$. At the intersection of the saturation line on the Mollier chart read $H_o = 1153$.

B. Find H_f. $P_f = \frac{1}{2}\ (30 - 28) = 1$ lb. and from the Mollier diagram $H_f = 972$.

C. Find $(H_o - H_f) = 1153 - 972 = 181$ B.t.u.

D. Calculate from the following equation the theoretical hp. which equals

$$\frac{\text{Flow} \times (H_o - H_f)}{2545}$$

Substituting the proper values

$$\frac{18{,}000 \times 181}{2545}$$

$$= 1280 \text{ hp.}$$

E. From the theoretical hp. = 1280 and rated r.p.m. = 3600 find a trial Eff. from Fig. 4 of 71 per cent, or as a fraction, 0.71.

F. Trial hp. = theoretical hp. $\times$ trial Eff. = 1280 $\times$ 0.71 = 910 hp.

G. From the trial hp. = 910 and rated r.p.m. = 3600 find the final Eff. from Fig. 4 is 68.1 per cent or 0.681.

H. Final hp. = theoretical hp. $\times$ final Eff. = 1280 $\times$ 0.681 = 871 hp.

Calculations like Example 4 above and Example 5 which follows are again of particular value to the industrial engineer. Steam for heating or process work is often supplied through a reducing valve, or reducing valve and desuperheater, so that the available heat drop between the high and low pressures is not utilized. If the use is intermittent or the flow very small, a turbine to regain this by-product power might not be justified. But under many conditions such a turbine is very practical and Example 3 shows how the available power may be calculated.

Example 5 is somewhat similar but in this case low pressure steam, perhaps from a non-condensing turbine or engine is assumed in order to show how to proceed under these conditions and to demonstrate how valuable steam, even at 3 lb. pressure is from the byproduct power standpoint. Of course the determination of whether it is economical to reclaim this power is a little more involved because a condenser and cooling water supply is involved.

To Find the Power Available from a Given Quantity of High Pressure Steam

Example 5: Find the power available from 12,000 lb. per hr. of high pressure steam when used in a 3600 r.p.m. multi-stage non-condensing turbine. Steam conditions: 450 lb. — 200 deg. F. — 150 lb.

A. Find H_o. $P_o = 450 + 15 = 465$ lb.; $D_o = 200$ deg. F.; and from the Mollier diagram $H_o = 1335$ B.t.u.

B. Find H_f. $P_f = 150 + 15 = 165$ lb. and from the Mollier diagram $H_f = 1229$ B.t.u.

C. Find $(H_o - H_f) = 1335 - 1229 = 106$ B.t.u.

D. Theoretical hp. is, from the same equation used in Example 4, equal to

$$\frac{12{,}000 \times 106}{2545}$$

$$= 500 \text{ hp.}$$

E. From theoretical hp. = 500 and rated r.p.m. = 3600 the trial Eff. from Fig. 6 is found as 61.5 per cent, or 0.615.

F. Trial hp. = theoretical hp. $\times$ trial Eff. = 500 $\times$ 0.615 = 308 hp.

G. From the trial hp. = 308 hp. and the rated r.p.m. = 3600 the final Eff. from Fig. 5 is 56.0 per cent, or 0.56.

H. Final hp. = theoretical hp. $\times$ final Eff. = 500 $\times$ 0.56 = 280 hp.

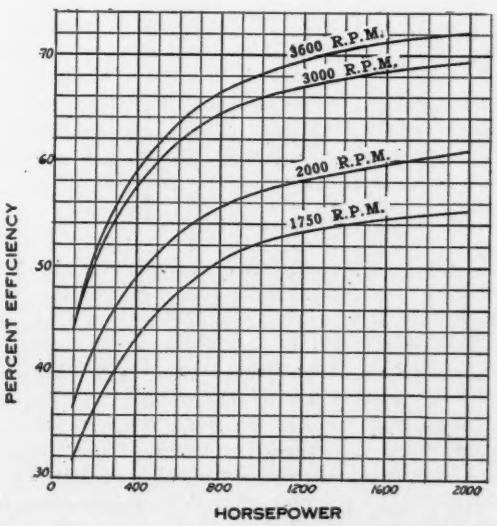


Fig. 6. Efficiency curves for multi-stage non-condensing turbines

DIESEL LUBRICATION — A New Approach

Part I. In the Diesel, the lubrication engineer meets his toughest problem. Temperature and time hold the secret of success, but lack of information on oil film temperatures and reliable laboratory service rating tests prevent lubrication passing from an art to a science. A trained engineer and experience are still the bases of successful application.

By E. H. HILLMAN
Technical Department Standard Oil Co. (Ind.), Chicago, Ill.

RATHER than classify Diesel engines according to design as trunk piston or cross-head, two cycle or four cycle, air injection or solid injection, some lubrication engineers prefer to classify them according to the temperature conditions to which the lubricating oil is subjected. It is safe to say that most operating problems are related either directly or indirectly to lubrication. Lubrication in turn is affected principally by temperature. Other factors such as pressures and speeds are capable of calculation and furthermore are easily met with all conventional oils. They do not introduce serious problems for the lubrication engineer. Temperature, on the other hand, has a most profound effect on lubrication.

Most obvious of these is the effect on oil viscosity. Most operators do not appreciate that the viscosity of a typical Diesel lubricating oil may vary fifty fold between a winter engine room temperature of possibly 55 deg. F. and a circulating system temperature of, say, 130 deg. F. The viscosity at 55 deg. F. may be 150 times the viscosity at a cylinder wall temperature of possibly 250 deg. F. With this profound effect of temperature on viscosity it is not surprising that some extra heavy oils flow "like molasses in January" in a cold engine room, and may even refuse to feed in a mechanical lubricator with consequent damage to the cylinder walls. Nor is it surprising that the low rate of heat transfer through limed up cylinder walls further reduces the oil viscosity to the point that lubrication failures have resulted.

Chemical Stability

In addition to the effect of temperature on viscosity or body of the oil, we must also consider the effect of heat on the chemical stability of the oil. It is here that the classification of lubricating systems according to oil heat conditions become most important. It is necessary to consider not only the temperature which the oil reaches but also the time that it is subjected to these temperatures. Lawyers have a saying that "time is the essence of all contracts." In a different sense the time of exposure to high temperatures is an important factor in selecting a Diesel oil.

Class I conditions are those encountered by crankcase oils of large low speed engines with mechanical lubricators supplying new oil only to the cylinders. Because of the large size of the engines the crankcase circulating oil runs rather cool. The considerable distance from the cylinders and pistons prevents much radiation of heat to the crankcase, and since there is no splash, heat is not directly conveyed to the circulating oil. Such engines may use oil or water for piston cooling. The former, especially if the oil coolers do not function efficiently, may heat the oil sufficiently to place it in the medium temperature class. There are no definite temperature limits, but crankcase oils in this low temperature class may run at 130 deg. F., or even lower. Such conditions do not impose undue strain on the oil.

Diesel Lubrication Classification

Class	Oil Application	Oil Temperature Conditions
I.	Bearings only	Low
II.	Cylinders only	High, once through
III.	Bearings and cylinders	Continuous low, intermittent high
IV.	Bearings and cylinders	Continuous medium, intermittent high

Class II systems are all those equipped with mechanical lubricators which supply oil to the cylinders in the unused condition only. No used oil is added to the lubricators. It is evident that such oils should withstand the high temperatures of pistons, rings and cylinder walls without excessive deposit formation. On the other hand they need not withstand such exposure for long since the oil is constantly being scraped down into the crankcase, or up into the combustion space, where it is consumed and replaced by fresh oil. This is an important point which will be referred to later.

Class III includes most designs of the well known crankcase scavenging two cycle engine. Crankcase temperatures are low because of the stream of scavenging air at room or lower temperature which is constantly cooling the bearing oil. Consequently the oil in the sump usually rises only moderately above room temperature.

The circulating pump supplies used bearing oil to the mechanical lubricator and it to the cylinders. Thus a partially deteriorated oil is supplied to the cylinders, but in this type of engine the deterioration normally is only moderate because of the lower temperatures found with crankcase scavenging. Oil consumption also assists in maintaining the quality of the cylinder oil because of the necessary dilution of the used oil with new oil. Consequently, we usually find that such engines show comparatively little deterioration of the crankcase or circulating oil, and as a result the used oil which is supplied to the cylinders is almost as good as if it were new oil. This is true even though the oil is quite black in color. It takes very little carbonaceous material to blacken even the lightest colored new oil. These engines might be considered as a combination of Class I and II from a lubrication standpoint.

Class IV is our old friend the splash lubrication system as exemplified in millions of automobile, truck and tractor engines. The cylinders are lubricated by oil thrown from the bearings. The bearings are oiled through the conventional circulating system with drilled crankshaft, connecting rods, etc. Obviously, most Diesel engines in this class are of small size and high speed—the automotive designs which are receiving so much attention today. This system of lubrication is, however, not new in the Diesel field. Some manufacturers of medium speed comparatively large engines have for years relied on oil "mist" from crankcase splash to lubricate the cylinders.

Class IV the Most Severe

It is apparent that of all the lubrication systems, this Class IV is hardest on the lubricating oil. With splash lubrication large quantities of oil are brought into contact with the hot pistons and cylinder walls. The small engine sizes bring the source of heat closer to the oil in the crankcase. The higher speed means more engine friction and a higher rate of heat flow from the cylinders. The force of competition to reduce weight and increase ratings leads to higher mean effective pressures. All these factors raise the crankcase oil to the comparatively high temperature typical of automotive carburetor engine service. Even the larger medium speed models may show crankcase temperatures of 150-200 deg. F. Thus, even before the oil reaches the cylinders, it is partially oxidized with the formation of some asphaltic products.

Re-use of Oil

Cylinder temperatures may be higher or lower than in the classes first considered, depending on the design and efficiency of the cooling, but in any case lubrication is more difficult because of the dirty oxidized oil being flushed over the rings. This oil is doubly contaminated; first, with the asphaltic oxidation products resulting from the higher crankcase temperatures and second from the carbonaceous and asphaltic sludges formed in the oil at the high piston and ring temperatures and then dripping into the crankcase. This re-use of oil over and over again for cylinder and ring lubrication is in strong contrast to the system of supplying new oil only to the cylinders, which is never returned once it escapes "upstairs" to the combustion space or "downstairs" to the crankcase.

The above is not in criticism of this lubrication system, which is simple, economical of oil and a success in millions of engines, but is intended only to point the need for care in oil selection especially in the case of Diesel engines where the nature of the combustion cycle subjects the oil to more severe conditions than is usually encountered in gasoline engine service.

Filtering or centrifuging is, of course, always desirable to assist in maintaining the quality of lubricating oils in service, and especially so in the case of Class IV systems, where the lubricating oil is subjected to the most severe conditions and is used over and over again. Good filters or centrifuges, of which there are a number on the market, will quite completely remove even very finely divided solid material. It is of course

(Continued on page 429)

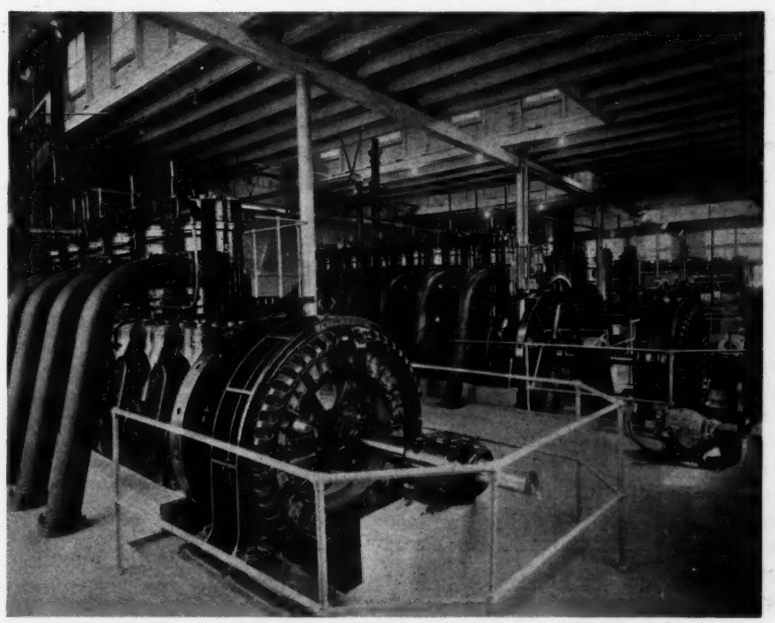


Fig. 1. Millions of horsepower in service prove that Diesels can be successfully lubricated but thousands of trained technologists over the world are constantly working to improve available oils and solve new problems brought about by new engine designs.

Diesel Fuel Pump Application

Injection Pump Characteristics Determine Engine Performance

By H. C. EDWARDS[1]

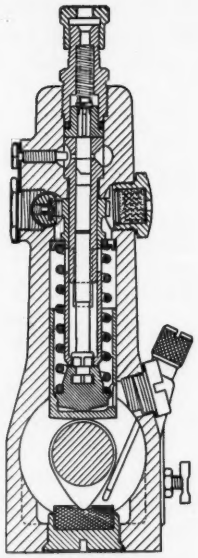


Fig. 2. Vertical section through pumps

ECONOMY in pounds of fuel per horse power hour will fix the shape of the horse power and torque curves when the delivery characteristics of the pump is known. For example, curves as illustrated in Fig. 1 would be produced by three different kinds of pump characteristics. If, for the same throttle setting, the delivery is more at low speeds than at high speeds, low speed performance as at A is good; if delivery is constant regardless of speed, the curve is shifted to B; or, if delivery increases with speed, better results will be obtained at the higher speeds as at C. Of course the engine economy will change with different quantities of fuel, but the above statements are substantially correct and the injection system will assist the engineer in establishing a particular engine performance if given proper adjustment.

Delivery of the pump can be determined broadly as a specific quantity at a given speed, but the engine combustion chamber determines the rate and type of burning. In order to produce a delivery quantity curve to fulfill the combustion requirements, we must make use of such variables as: Plunger size; delivery valve; cam contour; injection tube size; nozzle opening pressure; and nozzle opening area.

Obviously, the use of a larger or smaller plunger size will affect the general overall delivery of the pump accordingly. The characteristic of the pump can be varied quite extensively by the delivery valve and the means by which this is accomplished will be discussed later. The cam contour has a definite effect on the pressure curve at the nozzle throughout injection duration, but its effect can be neutralized or accentuated through the use of different nozzles. Injection tube size can be used as a control for pressure surges to eliminate any tendency toward any particular irregularity in injection duration from this cause. The nozzle opening pressure and opening area combined with other characteristics which are built into present day nozzles are used to adjust the pump delivery characteristic to the combustion chamber.

In detail, displacement of the discharge valve piston depends upon: Velocity of flow; piston valve weight; piston valve fluid passage area and contour, and spring load; all these factors except the last involve the function of time. Increased velocity causes greater valve displacement. Increased valve weight, fluid passage area and spring force reduce valve displacement. The values, which are fixed regardless of speed, must be, therefore, selected to accommodate the predetermined engine speeds and fuel quantities so that fuel delivered will be modified by speed to obtain the desired engine performance.

At any one throttle position, the effect of pumping more fuel at low speeds than at high speeds, as caused by the delivery valve, is partially counteracted by the natural functioning of a plunger working in a ported barrel of the type shown by Fig. 2. As the plunger rises to close the port with its advancing edge, pressure rises in the pumping chamber at different rates depending upon the plunger speed. At low speed, the pressure probably has risen high enough to start actual delivery

[1]Chief Engineer, Fuel Injection Div., The Timken Roller Bearing Co., Canton, O. This article is an abstract of a paper presented before the S.A.E. tractor meeting at Peoria, Ill., April 21-23, 1937. The pump referred to in the paper was described on page 159 of the March, 1937, issue of Power Plant Engineering.

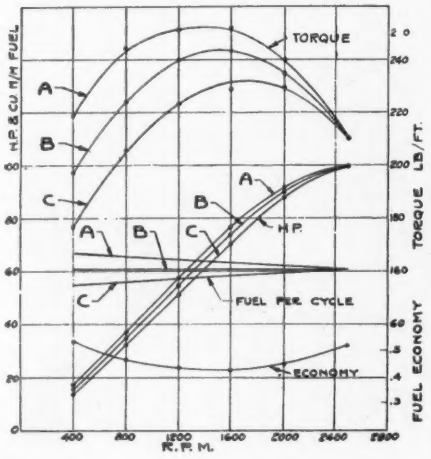


Fig. 1. Engine performance at fixed fuel economy depends on the injection pump characteristics

only when the port is completely closed. At high speeds, due to insufficient time allowed for the by-passing fuel to escape, this pressure may be high enough to start delivery long before the port is covered, hence the plunger's effective stroke has been lengthened and more fuel is delivered. Leakage also tends to cause greater delivery at the higher speeds.

Natural delivery characteristic as produced by the action of the plunger and port, if all the fuel which passes a delivery valve is forced on through the nozzle, would be represented by curve C of Fig. 1. Characteristics A and B are brought about by variations of delivery valve piston weight and fluid passage with their effect on pressure unloading and spring load. Formulae for the determination of these factors are available, but final results must be checked by engine performance since other injection requirements must also be accounted for to fit the injection rate to the combustion chamber burning rate.

In the case of a constant velocity cam[2] it will be noted that there is a fairly short period of high acceleration followed by a period of constant velocity with acceleration at zero, after which comes a period of deceleration. We might mention that this period of low deceleration is well along in the stroke, which makes it possible to use quite a light spring to handle high speeds.

Combustion chamber types and needs may be summarized as follows:

1. In a direct injection combustion chamber, the duration of injection must be short, fuel atomization must be very fine, penetration moderate, and with good control over the rate of fuel entry. Indications are that a multiple hole spray would be satisfactory.
2. Combination direct injection and air cell construction requires fast injection. Very good atomization is not so necessary, but high penetration and fair control over rate of fuel entry are required. A single hole nozzle is indicated.
3. A precombustion chamber type without turbulence requires fairly fast injection with fair atomization, low penetration, and fair control over the rate of fuel entry. A large pintle nozzle would probably be satisfactory.
4. A precombustion chamber with high turbulence functions best with a moderate injection duration. Good atomization, low penetration and fair control over the rate of fuel entry are essential. A moderate size pintle nozzle is indicated.

Although the injection pump plunger size and velocity has a great deal to do with the fitting of spray to the combustion chamber, it can only go part way. The nozzle itself is an important factor which must be worked out carefully in conjunction with the pump, but to arrive at a starting point, it is possible to set down a trial specification for the pump plunger sizes and cam outline based on general knowledge of the combustion chamber type.

Analyzing first an engine of the direct injection type, which at 100 hp. and 2500 r.p.m. has an economy of 0.5 lb. per hp. hr., or, converting to metric measurements and pump strokes, 61 cubic millimeters per pump stroke. A direct injection combustion chamber will require from 12 to 15 degrees of crankshaft rotation during injection. A mean of 13.5 deg. will amount to 6.7 deg. on the pump camshaft or .0009 sec. in lapsed time. With a constant velocity cam, the required plunger area will be 39.0 sq. mm.

This is nearly a 7 mm. diameter plunger and its effective stroke is 0.0624 inch or 1.58 mm. The portion of the total cam lift of 0.375 inch used for the effective stroke is shown in Fig. 3. Injection starts, or rather the port closes, after the plunger has raised 0.080 in. The effective stroke continues 0.0624 in. further before the 61 cu. mm. have been discharged through the delivery valve. An examination of the accompanying velocity of 5.7 ft. per sec. shows that it would be possible to inject 125 c. mm. of fuel at this rate with this size plunger. Therefore, if tests indicate the necessity for a certain amount of delivery valve retraction[3] volume, any volume up to 64 cu. mm. to reduce line surges, produce good idling, or maintain true injections of constant duration, can be used without disturbing effective cam velocity.

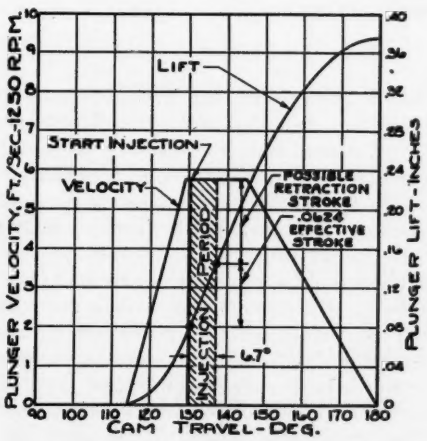
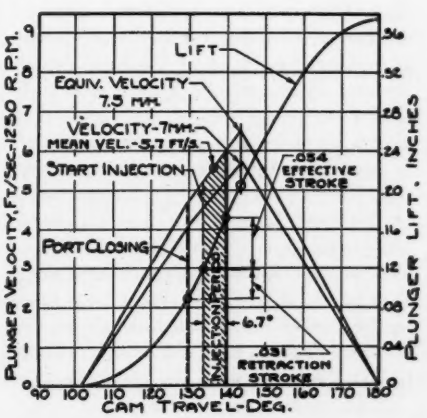


Fig. 3. (Left) Performance of 7 mm. diam. plunger pumps driven by a constant velocity cam to deliver 61 cu. mm. over an injection period of 6.7 deg. of camshaft rotation

Fig. 4. (Right) Performance of a 7.5 mm. diam. plunger pump driven by a variable velocity cam to deliver 61 cu. mm. over 6.7 deg. of camshaft rotation



[2]A constant velocity cam is one so designed that the fuel pump piston or plunger operated by the cam is moving at a constant rate of speed during that portion of the stroke during which injection takes place. In other words, fuel oil is sprayed or injected into the cylinders at a constant rate from the time injection begins until it stops.

[3]The term retractive stroke may be defined as that part of the fuel pump plunger or piston stroke which takes place in advance of the effective stroke, occurring while pressure in the delivery line is being raised to nozzle or discharge pressure.

KOPPITZ

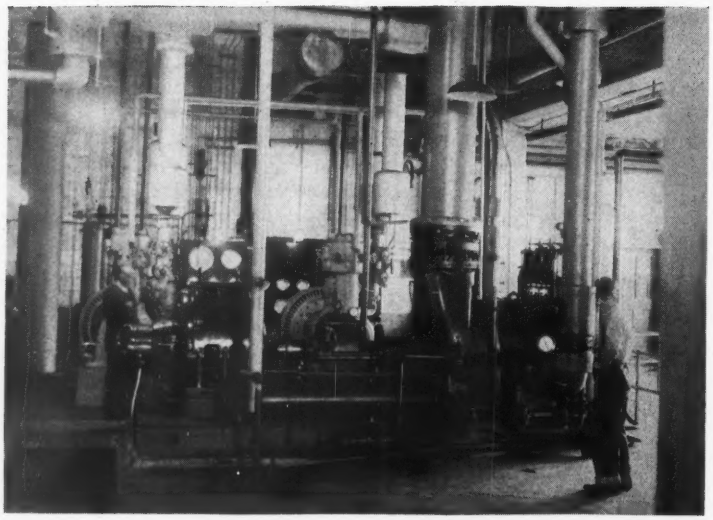


Fig. 1. The engine room with the turbo-generator in the foreground and the two compressors in the background

SUPPLYING MICHIGAN with Detroit's original Pale Select Beer is a tradition in the Koppitz family dating back many decades to the old Koppitz-Melchers Brewery. During prohibition the old brewery was converted to other uses and the present one, built new from the ground up at Du Bois Street and the River in Detroit, is one of the very few which has been able to take advantage both of advances in the art of brewing and modern industrial layout without the compromises always found necessary when revamping an old building.

Furthermore, B. A. Koppitz, president of the company and son of the founder, is an engineer as well as a brewer for he was chief engineer of the old brewery. Like Henry Ford, he retains his interest and pride in the power plant and has spared no pains to see that it is not only as modern as the brewing itself, but, that it is well adapted to the purpose which it serves.

Power Plant

With the exception of the coal conveyors and controlled superheat, the boiler room with two boilers follows conventional lines but the engine room does not. It is laid out with a keen appreciation of the fundamental part played by power, steam and refrigeration in the process, and, as shown by Fig. 4, is built as part of the brew house without a curtain wall between. Turbo-generator, switchboard, compressors and pumps are on the main floor with the feedwater heater, steam and ammonia condenser on a gallery between the boiler and turbine rooms and about 25 ft. above the main floor. Although there is an emergency lighting tie-in with the utility system, all power used in the brewery is generated in the plant. The power plant as set up may be operated efficiently at either minimum or normal present brewing capacity while ample provision has been made for expansion of the power, steam and refrigeration requirements when the brewery is extended to maximum capacity.

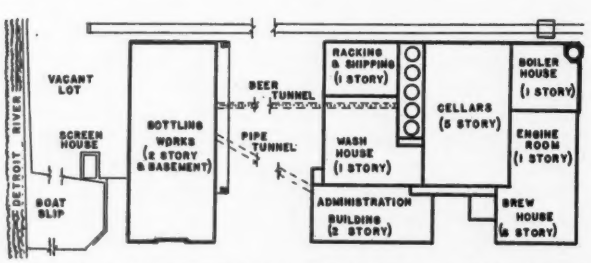


Fig. 2. Plan of the grounds. The main building is connected to the bottling building by a 4 by 4 ft. tunnel 124 ft. long containing cold water, compressed air, CO_2, gas, steam and return lines

Brewing Process

For those not familiar with the brewing process, a short description may be of interest. Beer is the fermented product of grains and is essentially a double chemical process involving the conversion of starch to sugar and then, by fermentation, of sugar to alcohol. The chief ingredients are germinated barley (malt), rice and corn. Germination develops the enzyme diastase capable of converting the starch of the malt, and cereal mixed with it, into sugar. Hops, which give the finished product its characteristic bitter taste, are added in the brew kettle to precipitate proteins, which would give the beer a cloudy appearance, and yeast is added in the fermenters to promote fermentation.

After grinding, the malt is cooked in the mash tub, and then mixed with the already cooked cereal. The final mash is washed with hot water, called sparging, and the resulting wort (unfermented beer) is drawn off to the brew kettle where it is cooked to the desired concentration for the multiple purpose of sterilizing, killing the enzymes, coagulating the albuminous matter and extracting solubles from the hops. Hops are then removed in the hop jack and the strained, hot wort is ready for cooling. Spent hops and grain are sold for cattle fodder.

Heat and Power

Up to this point the process requires heat for cooking and heating water, and, power for pumping and grain handling, but from hereon power and refrigeration are required. Refrigeration is needed for cooling the wort and maintaining proper temperatures in the fermentation, storage and barreling cellars. Close control of cooking, fermentation, storage and carbonization must be maintained regardless of variations in atmospheric and raw material conditions.

Efficient utilization of power, heat and refrigeration calls for minimum handling of raw materials as well as for utilization of cold water, and waste heat

Pale Select Beer for Detroit

Koppitz-Melchers, Inc., builds new and modern brewery. Present equipment consists of one 310 bbl. kettle, two 250-hp. stoker fired boilers, two 75-t. refrigerating compressors and one 350-kw. turbo-generator. Space is provided for expansion.

from cooling, to best advantage. These have been worked out unusually well in the new brewery. In addition, the brew kettle, ordinarily supplied with steam at 20 to 30 lb., has a 6 in. dia. fire coil on the inside. This fire coil is supplied with hot gases from a separate oil fired unit so that it may be heated by either, or both, steam and oil to give unusual flexibility.

Brewery

The main house is seven stories high, and the layout is simple and direct, involving as little handling as possible and taking full advantage of gravity. As shown by the flow diagram, Fig. 3, malt, received in bulk, is elevated from the track hopper to a storage bin and when needed is reclaimed by the same Redler conveyor for delivery through the scale hopper and malt mill to the mash tubs. Rice and corn grits sacked, because they are imported, are carried by a sack elevator to a storage handy to the rice scale hopper for direct delivery to the rice cooker.

Cooling

This cooker is on the same level as the mash tubs and Lauter tank. From this last tank the wort is delivered by gravity to the kettle and then to the hop jack, on the ground floor. The wort is then pumped to the cooler in the tower and flows by gravity over the BOUDELET coolers to the fermenting vats, coolers and storage cellars. After aging it is passed through the Government tanks on its way to be barreled, or, bottled and sterilized. As shown by the plan, Fig. 1, the barrel rack is part of the main building while the bottling department is in a separate building close to the river.

With an abundance of river water to be had for the pumping, condenser cooling water presented no problem. At the river intake debris is removed from the water by a Chain Belt traveling screen in the screen house shown by Fig. 5. Being built at the end of the slip, this house is protected from boats and barges by special fender piles located outside of the coarse grill. Inside sluice gates are provided so as to allow dewatering and inspection of the screen pit.

River Water

River pumps are located in the engine room near the turbines as shown by Fig. 9. These duplicate units, equipped with Elliott Twin strainers, are rated at 300 g.p.m. against a 75 ft. head and are each driven by a 30 hp., 1200 r.p.m. motor. These motors, like all motors in the plant, outside of a few smaller ones which come as individual drives on assembled equipment, are Louis Allis, while the pumps are without exception American Marsh with Smolensky check valves. Water used for drinking and process purposes is taken from the city system and pumped, through a Badger meter, by two 300 g.p.m., 85 ft. head booster pumps with 10-hp., 1750 r.p.m. motors, to a tank in the tower. It is then used direct, or, flows by gravity, over the BAUDELOT wort cooler to a warm water storage tank below to be used for the next brew.

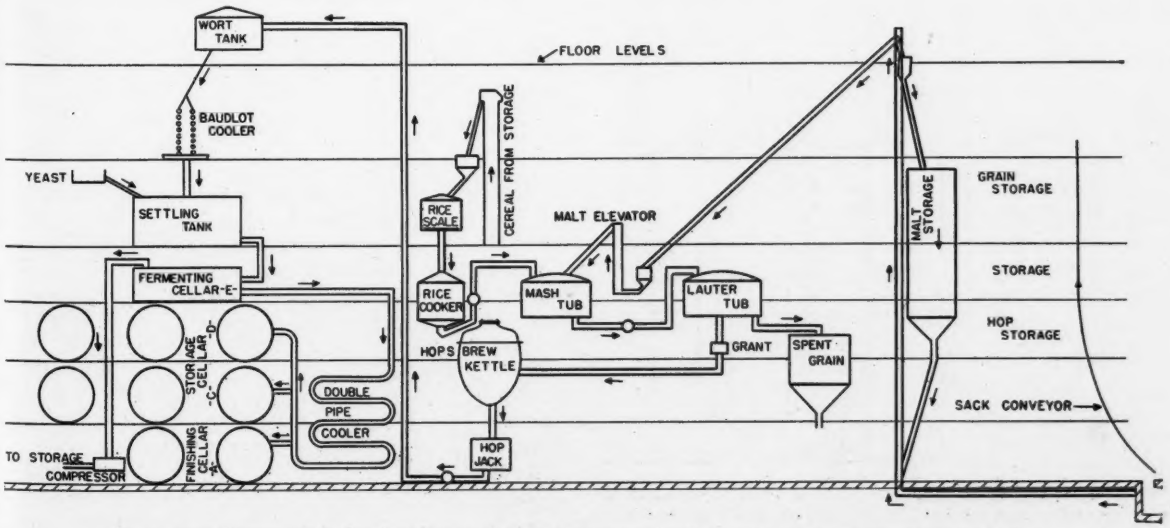


Fig. 3. Flow diagram of the brewery showing the brewing process from the grain storage to the fermenting cellars

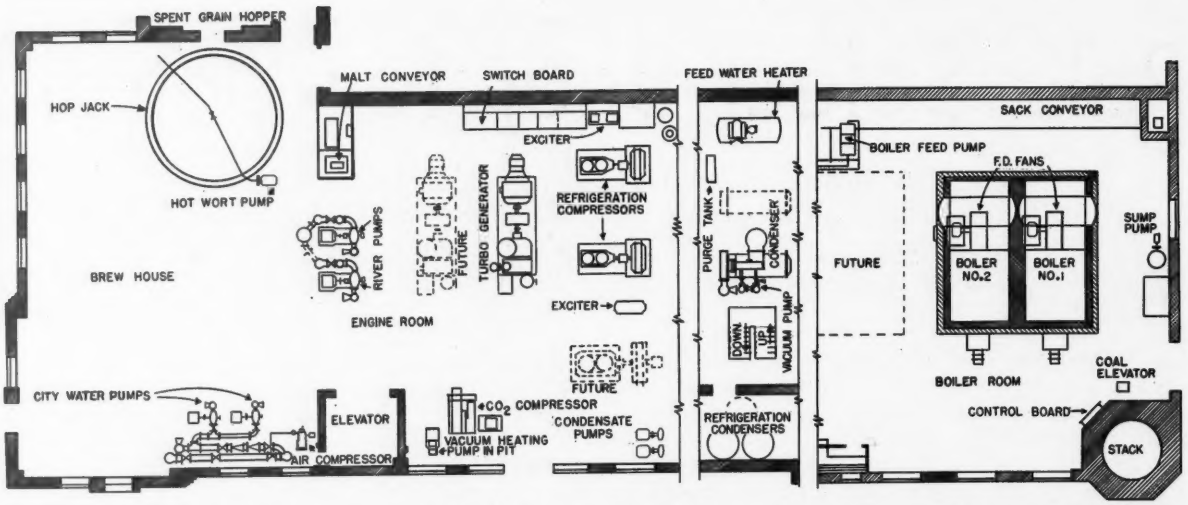


Fig. 4. Plan of the boiler and turbine rooms. The gallery shown in the center is 24 ft. above the main floor. The boiler room and turbine room adjoin but have been separated in the above drawing to show the relative position of the condensers and feedwater heater on the gallery

Compressed air at 40 lb. is supplied by a Nash compressor, with a 3450 r.p.m., 15-hp. motor, and, CO_2 collected from the closed fermenters, is compressed to 250 lb. by a two stage, Enzinger-Union compressor chain driven by a 7.5-hp., 1150 r.p.m. motor automatically controlled so as to hold a suction pressure of 1½ to 3 lb. Returns from the heating system are pumped to the feedwater heater by a pump and receiver set rated at 20,000 sq. ft. of radiation. All of these pumps are located in the engine room.

Space Cooling

All refrigeration equipment is Carbondale. The two main compressors, rated at 75 t. each, are 10 by 10 in. duplex vertical single acting units direct connected to 125-hp., 440-v. synchronous motors. Two condensers of the shell and tube type are installed on the gallery with space provided for a future compressor and condenser as indicated on the drawings. An additional brine cooler of the shell and tube type is provided in storage cellar C on the second floor.

Space cooling throughout the cellars, is by Clarage Unitherm coolers of either the brine spray or fin tube type. These units, 10 of the former and 4 of the latter, are all of the direct expansion type using ammonia under flooded operation, each unit having its own float control chamber and accumulator. In the fin tube type air is drawn in over the coils for cooling while in the brine spray type the coils are submerged in brine which is circulated by an auxiliary pump and sprayed into the incoming air for cooling purposes. Eliminators remove the excess brine and condensed moisture before delivery from the unit. Typical applications are shown by Fig. 6 where the air is recirculated, cooled constantly and distributed to the room when desired by means of ducts.

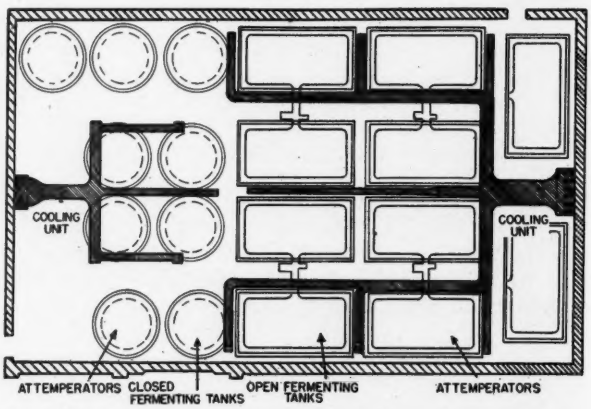


Fig. 6. Arrangement of the cooling units in the fermenting cellars. Some of the fermenters are enclosed so that the CO_2 may be collected and compressed for carbonating

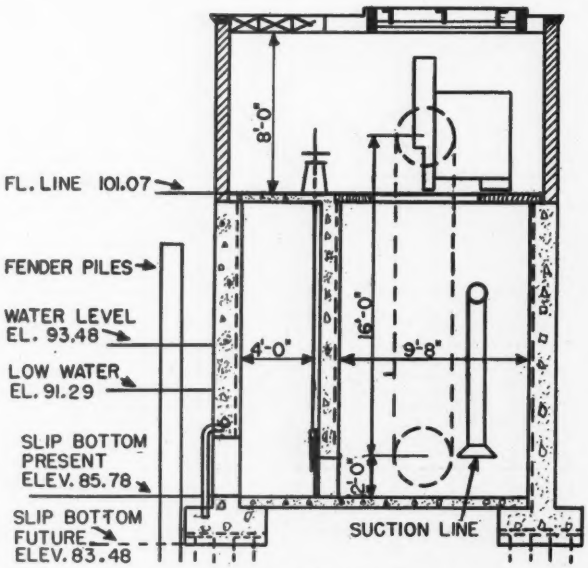


Fig. 5. Section through the screen house

In the wort cooler room a different cooling system is used due to air being taken in from the outside, filtered, tempered and washed in a Buffalo washer and delivered to the BAUDELOT cooler room by ducts so that the room is always under a slight pressure to avoid infiltration of unwashed air.

Electric power is generated by an Elliott 350-kw.,

440-v., 3-ph., 60-cycle, 3600 r.p.m. turbo generator designed for extraction-condensing operation. Steam is supplied at 200 lb., 50 deg. F. superheat, with extraction at 35 lb. At light loads the extracted steam is superheated so that a Swartwout desuperheater is installed in this line to insure saturated steam in the process lines.

Power Generation

This turbine exhausts vertically to a 525 sq. ft., 3 pass Elliott condenser on the gallery between the boiler and turbine room. Space is provided as shown by Fig. 4 for another turbine unit and steam condenser. Arrangement and design of the switchboard with an extra panel for another generator is shown by Fig. 9. The condenser is equipped with an Elliott steam jet vacuum pump and two 1¼-in. American Marsh hotwell pumps, driven by 3-hp., 3475 r.p.m. motors, and installed

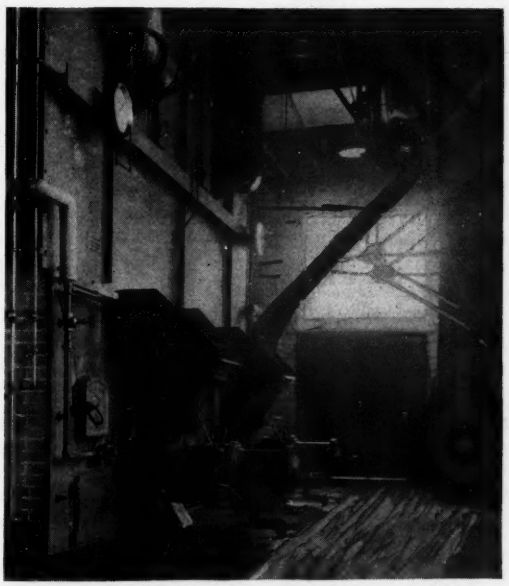


Fig. 7. Two 250-hp. stoker fired boilers are installed

in a corner of the engine room adjacent to the boiler room door. An Elliott 33,000 lb. per hr. deaerating type feedwater heater is also located on the gallery almost directly above the 7½ by 4½ by 10 in. simplex boiler feed pump.

Both boilers are of the Wickes 250 lb., three drum type with 2500 sq. ft. of heating surface and equipped with Turner controlled heat superheaters designed to give 50 deg. superheat. They are fired by Riley single retort underfeed stokers hydraulically driven. Forced draft is supplied by individual Clarage Type W, design 1, size 1¾ fans, equipped with Fafnir bearings and driven through V belts by 10-hp., 1770 r.p.m. motors. These same motors drive an oil pump, incorporated in the special base shown by Fig. 8, which supplied oil for driving the stokers.

Control

Stokers, fans and dampers are under the control of a Cash regulator. The boiler panel is equipped with an Ellison draft gage and Brown flow meter. Both boilers are equipped with Jenkins blowoff valves, Swartwout "S-C" feedwater regulators and Tracifiers, the latter being drained by Nicholson traps. Boilers are

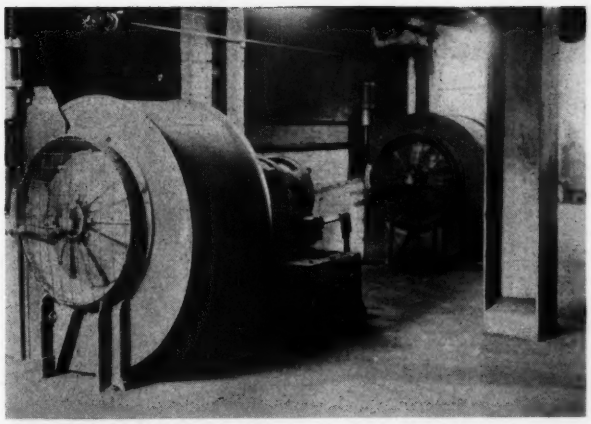


Fig. 8. Each boiler has one forced draft fan. The oil pump for the hydraulic drive on the stoker is incorporated in the motor base

designed for 200 per cent rating so that one boiler can handle the peak load of about 500 b.hp.

Coal Handling

Coal received by rail is dumped in a track hopper and handled by Redler conveyors. The first, driven by a 7½-hp. geared motor, clears the track hopper, elevates and discharges to a horizontal conveyor driven by a 2-hp. motor for delivery to the hopper. From there the coal is delivered to the stoker hoppers by a 100 lb. Stephens-Adamson weigh larry. Ash is handled by a Frederick steam jet system, a Nash sump pump, driven by a 1-hp., 3450 r.p.m., Westinghouse motor, is also installed in the boiler room to handle wash water and dirty drips.

As might be expected from a plant so carefully designed, a complete piping cooler code has been worked out to facilitate operation. This code is as follows: Superheated steam, brown; extraction steam, gray; hot water, yellow; river water, blue; tank water, dark green; city water, light green; returns, orange, and ammonia, orange.

B. A. Koppitz is president and general manager of Koppitz-Melchers, Inc., John A. W. Hartung is superintendent and brewmaster, and W. L. Heglin is chief engineer. Mildner-Eisen of Detroit were architects and engineers with A. F. Caughey as consulting mechanical engineer.

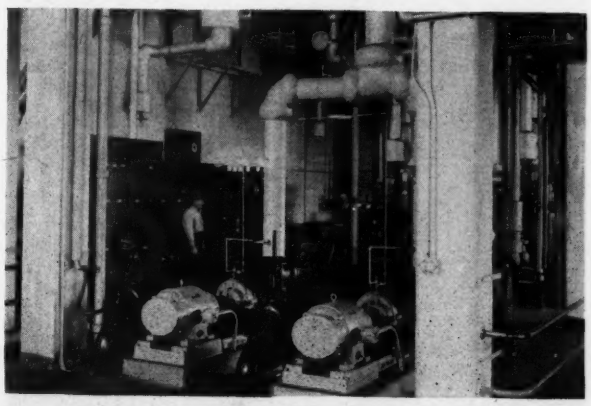


Fig. 9. Another view of the engine room showing the switchboard and river pumps

Electron Tubes—

PART XVII

By A. W. KRAMER

THE STRANGE RELATION between the frequency of the incident light and the speed of the ejected electron in the photoelectric effect which was described in the preceding chapter has an important bearing upon the application of the phototube for it provides the latter with a color-sensitive response characteristic. This sounds rather "high hat" but it is only the technical way of saying that the phototube is able to distinguish between light of different colors, just as the human eye does. Thus in the sorting of cigars, a phototube can be mounted in front of a small conveyor carrying the cigars so that if a cigar of a lighter or darker shade of brown than that of the normal run happens to pass by, the phototube would instantly detect it and through a system of relays and control apparatus cause that "off-color" cigar to be removed from the conveyor. Naturally, this ability of the phototube to distinguish between light of different color is one of its most valuable characteristics; for one thing, it provides us with a means of matching colors far more accurate than anything we have known before.

This aspect of photoelectric phenomena is very much like that of a photographic plate or film. Even those not seriously addicted to amateur photography know that a photographic plate will be "spoiled" if exposed to even very weak white light for a brief instant, whereas that same plate can be safely handled in the relatively strong red light of the photographic dark room. In the same way a phototube can be made which is very much more sensitive to, say, blue or green light than it is to red light. All the red light in the world would not actuate such a tube. Other phototubes are made which will not respond to visible light at all but which are highly sensitive in the ultra violet region.

The difference in the color response of various phototubes, as may be suspected, is due to differences in the cathode surface. As was pointed out in an earlier chapter, some substances emit electrons under the action of light more easily than others; some substances require light of relatively high frequency (ultra violet light for example) for the emission of electrons while other substances give copious emission with light of relatively low frequency. Such substances naturally would be used on the cathode surface of a tube intended to respond to red or yellow light.

The physical principles underlying this "selective" action are quite complicated and involve an intimate knowledge of the forces which hold the atoms and electrons in various materials together. As was disclosed in the preceding chapter, the radiant energy

Principles and Applications

More about frequency and its effect upon the operation of phototubes. Color response, its significance upon the phototubes' application.

travels through space in quanta or bundles—lumps, if you please, each of which can be handled over to matter in its entirety but not in part. If, in a specific case, the energy in a quanta is equal to the force which holds an electron in place, this quanta will be able to knock such an electron out of the material in which it resides.

The forces with which electrons are held in place in various substances varies widely, just as the forces with which atoms and molecules are held in place vary widely in different materials. The energy in light, we have learned, is also a variable quantity, increasing with the frequency of the radiation. Therefore, it is obvious that if the frequency of the radiation is high enough, the energy will be sufficient to overcome the electrical forces between the electrons and atoms of the material exposed and emission will take place. This is perhaps a crude way of explaining it but, in principle, this is essentially what takes place.

Now, it becomes evident why certain substances are much more suitable than others for photoelectric emission. Obviously, those materials in which there are a large number of free electrons more or less loosely bound will provide high emission; the metals, for example, would be expected to be better emitters than the non-metals and this, actually, is the case. Even among the metals, however, there is considerable difference in the forces holding the electrons in place and it has been found that the alkali metals provide the greatest emission with the lowest radiation quanta. These, therefore, are the metals most suitable for photoelectric work.

It is not the object here to enter into a technical discussion of the theory of photoelectric emission but one or two facts should be mentioned. One of these is a factor, usually referred to as "surface work." This is the term given to the amount of work required to enable an electron to overcome the forces which exist at the boundary of any surface. It might be compared to the work required by a molecule of water to overcome the surface tension of the liquid in the ordinary process of evaporation. As is well known, the surface of any liquid is characterized by a "surface tension" which tends to keep the molecules of the liquid from leaving the liquid. When such a liquid is heated, the increased kinetic energy given to the molecules enables some of them—those very close to the surface—to escape into the space above.

A similar condition exists at the surface of a metal so far as electronic emission is concerned. Whether the emission is thermionic or photoelectric, before an electron can be emitted, it must acquire sufficient kinetic energy to overcome the surface tension of the metal. It is evident, therefore, that metals having a low work function or surface tension are most suitable for photoelectric work.

The surface work of the principal alkali metals used in photoelectric work is given as follows:

Lithium	2.36
Sodium	1.82
Potassium	1.55
Rubidium	1.45
Caesium	1.36

From this it will be apparent that unless for some special reason it is not feasible to do so, caesium should be used for the cathode of a phototube. Its surface work is so low that quanta of little energy content may be used to excite it and this means that it will be sensitive to the red end of the spectrum. Today caesium is used more than any other for phototubes responding to ordinary light.

There are a number of other factors which determine the performance of a phototube; aside from the metal used the character of the surface itself has an important bearing. Today the plain metals are rarely used for the cathode surface. They are nearly always used in the "sensitized" or thin film condition. There are two main processes of sensitization. The first was discovered more than 30 yr. ago by Elster and Geitel, and was used in all emission cells adapted for the visible spectrum for some 20 yr.[1] It consisted in mak-

[1] The light-sensitive cell is not a new device. It is about 40 yr. old which is really an ancient device scientifically speaking. As pointed out, the fact that certain surfaces emitted electricity when illuminated has been known since the time of Hertz in 1887 but the rapid development of the photocell into a rugged, uniform, long-lived product has taken place in the last six years.

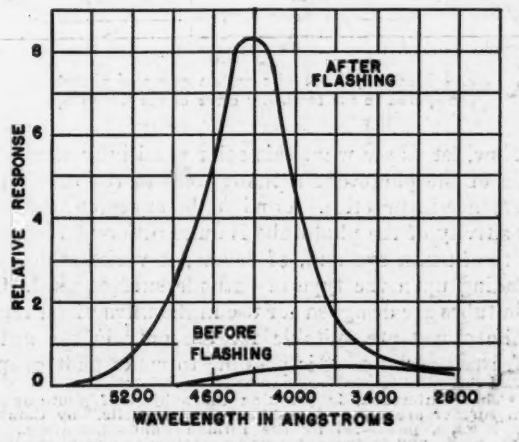


Fig. 1 Curves showing the effect of "flashing" upon the sensitivity of the cathode surface

ing the metal the cathode of a glow discharge in hydrogen. It is accompanied by a change in the appearance of the surface; thus the white metallic potassium becomes matt and assumes a characteristic blue-green color. The increase in sensitivity obtained by this "flashing" process is quite remarkable, as is shown by the curve in Fig. 1. The second process developed during the last eight years consists in exposing the metal for a short time to the action of vapors containing oxygen or sulphur.

There are other processes of preparing cathode surfaces by the deposition of thin films of alkali metals upon insensitive metals (Platinum for example) or upon the glass wall of the tube itself. Pure sodium may be deposited upon the inside of a tube by passing an electrolytic current right through the glass. The bulb is immersed in a molten bath of sodium nitrate; the current flowing from the bath through the glass (which must be soda glass) deposits the pure sodium on the inner wall of the bulb. Pure sodium, however, is not a very efficient photoelectric emitter so that cells prepared in this manner are not sensitive, though they are very permanent in their performance.

So much for the formation of the cathode surfaces. These matters do not concern the ordinary use of the phototube since they involve only design and manufacturing considerations but they are of general interest in that they give some insight into the scientific basis for the existence of the phototube. The phototube is a simple enough device in its make up but it is quite apparent even from the limited treatment of it given here that its design is based upon profound physical, chemical and electrical knowledge[2]. It is at once the product as well as an important tool of scientific research.

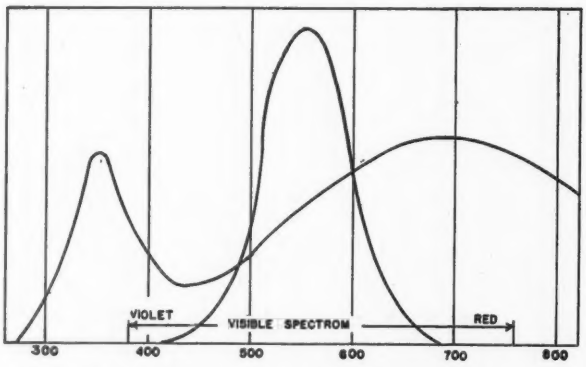


Fig. 2 Sensitivity curve of a certain group of phototubes compared to the sensitivity curve of the human eye

Now, let us see what this color sensitivity characteristic of the phototube actually does to the tube's performance in practice. As might be expected, the color sensitivity of the phototube is quite different from that of the human eye and, of course, it varies widely depending upon the type of cathode surface used. Certain tubes are designed for use in the ultra violet region while others are suitable for use only in the red or infra red. Just as it is possible to make photographic plates which are sensitive to certain regions of the spectrum so also is it possible to make phototubes sensitive to some particular part of the spectrum. Fundamentally, the color response is determined by the cathode surface but a standard tube can often be provided with a light filter to effect the same purpose.

In Fig. 2 is shown a curve representing the color sensitivity of a number of well known commercial phototubes together with another curve on the same chart and drawn to the same scale, representing the sensitivity of the human eye. As will be seen there is little similarity between these two curves, the phototube having an entirely different characteristic from that of the eye. It is highly sensitive in the red region of the spectrum and also in the ultra-violet.

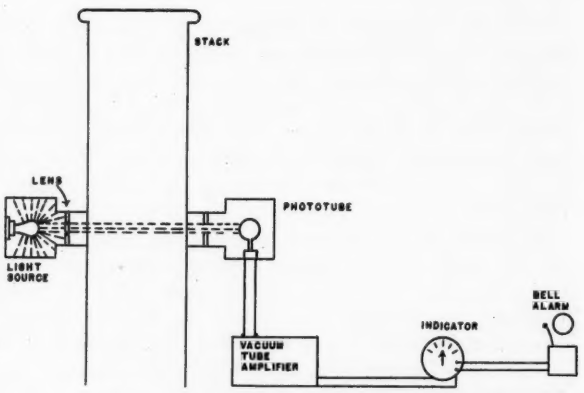


Fig. 3 The simple elements of a photoelectric smoke indicator and alarm

Comparing these two curves, the one for the phototube and the one for the eye, at first it might be assumed that this difference in shape might be unfavorable to the use of the tube as a device for the measurement of color. If one stops to think about the matter, however, it will be apparent that as far as the phototube is concerned, this type of curve is very well suited to the use of color measurement, for it will be noted that except for those regions in the extreme violet and red, the curve is linear. Consequently, if the color of the incident light is varied uniformly from violet to red, through the entire range of the spectrum, and assuming that the intensity of illumination remains the same, there will be a gradual increase in the current output of the tubes which can be interpreted in terms of color or wave length. This is purely theoretical. Color meters using the phototube are not as simple as this but the principle will be obvious.

For most industrial uses, the ability of a phototube to discriminate between light of different color is of less importance than high sensitivity in some particular region of the spectrum either within or outside of the visible range. In sorting operations such as the inspection of cigars referred to above, color discrimination is necessary but only to a limited degree. In most instances all that is necessary is that the tube be responsive to changes in light intensity. Thus in a smoke indicator, a phototube tube installed in the side of a breeching or stack responds to the varying intensity of a beam of light transmitted across the smoke flue. The fundamental principle of such a device is shown

[2] Those interested in persuing the subject of phototube design further are referred to "Photoelectric Cells," by Campbell and Ritchie, published by the Pitman Publishing Corp., New York, N. Y., and to the chapters on photocells and photoelectric phenomena in Morecroft's "Electron Tubes" published by John Wiley & Sons, Inc., New York, N. Y.

in Fig. 3. In this case the intensity of the smoke is indicated by a milliameter (calibrated in terms of smoke density) in the plate circuit of the vacuum tube amplifier which is provided with contacts for operating an alarm bell when the smoke density exceeds a predetermined limit.

In cases where a phototube must respond to ultra-violet radiation it is not only necessary to provide a cathode surface with the proper characteristics, but the proper type of glass envelope must also be provided. In Fig. 4 is shown a curve representing the color sensitivity of a phototube designed to give a high current output when exposed to ultra-violet radiation. The tube, however, must be made of quartz if this ultra-violet sensitivity is to be attained, since quartz will transmit ultra-violet radiation. If this same tube is provided with a glass envelope, the response curve will be that shown by the dotted portion. The glass absorbs nearly all of the ultra-violet radiation permitting little light energy from reaching the cathode surface. Ultra-violet phototube are useful in scientific measurement work and in protective systems against burglary.

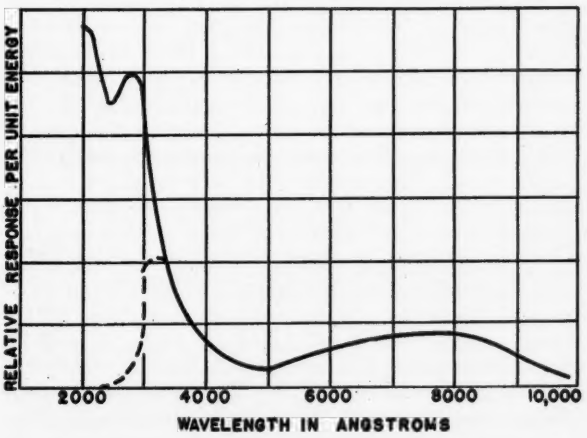


Fig. 4 Curve showing the effect of the material of the envelope of a phototube. The full curve shows the frequency response curve of a tube with a quartz envelope while the dotted portion shows how the sensitivity drops off at the high frequency end if a glass tube is substituted for the quartz tube

These few instances will serve to indicate the nature of the problem involved in the application of the phototube. A knowledge of the characteristics of the phototube is essential as is also a general understanding of its operation.

Thus far, we have mentioned only phototubes of what is known as the photo-emissive class—those of the high vacuum type as well as the gas filled. There are available, however, other light sensitive tubes or cells which operate on a different principle than those described.

In general, there are two other types of light sensitive devices, one group known as photo-conductive devices and the other, photo-voltaic devices. Of the photo-conductive group, the selenium cell is the most prominent example. As is quite well known, selenium has the peculiar property when placed in an electric circuit of changing its resistance in accordance with the intensity of light falling on it. Normally, selenium exhibits a high resistance to the flow of electricity but when it is illuminated, this resistance decreases. The ratio between the dark and light resistance may be as much as 10 to 25 times.

This property of selenium has been known for many years, since 1872 in fact, but until recently little success was had in adapting it for use as a light sensitive control device. By a special technique of forming the selenium surface in a vacuum and annealing it in a dry, inert gas, many of the earlier difficulties have been removed and a stable, useful selenium cell is commercially available today. Its color response compares favorably with many of the photo-emissive tubes but its speed of response is considerably slower. Whereas the photo-emissive tube can respond to variations in light intensity of millions of cycles per second, the photo-conductive cell is capable of responding only to changes of tens of hundreds of cycles per second. As actually built, selenium cells are generally sealed up in glass tubes filled with helium or similar gas and have a dark resistance of a megohm or more.

The photo-voltaic cell which has come into use during the past few years operates upon the principle that an e.m.f. is created in an electrolyte or across a set of electrodes when the electrolyte or electrodes are illuminated. Thus with a device of this kind no other source of potential is necessary—it provides its own. Several types of these cells are commercially available. The Photox made by the Westinghouse Electric and Manufacturing Co. is a copper oxide cell, consisting of a copper disk oxidized on one surface with a transparent film of metal deposited on the oxide. The Weston Photronic cell made by the Weston Electrical Instrument Co. consists of a thin metal disk on which is deposited a film of light sensitive material. The metal disk is the positive terminal while a metallic collector ring in contact with the light sensitive surface is the negative terminal. The element in the General Electric photo-voltaic cell consists of a layer of selenium deposited on the surface of a steel plate. Over this layer of selenium, two transparent layers of conducting metal are deposited, this making the negative terminal of the cell. Another make of photo-voltaic cell is the "Eletrocell." This consists of a semi-conductive layer deposited on the surface of an iron disk and overlayed by a transparent conducting film.

As will be noted, although the materials differ, the fundamental principle involved in all of these photo-voltaic cells is the same. All of them make use of the Becquerel effect, discovered over a hundred years ago. Becquerel noticed that if two similar electrodes were immersed in an electrolyte and one of them was illuminated more than the other, the device developed a voltage.

The photo-voltaic cells we have been discussing are of the dry type, no electrolytes of any kind entering into their make-up, but in principle they are similar to cells using electrolytes. The fact that no auxiliary batteries or other sources of electromotive force are necessary make them exceedingly compact and portable. Their current output is high compared to that of the photo-emissive type of cell, in some instances ten times as high. These cells in many ways constitute a special class of light sensitive devices and since they are becoming increasingly important they will be considered in greater detail in a subsequent article.

Edison Electric

THE FIFTH ANNUAL CONVENTION of the Edison Electric Institute which was held at the Palmer House in Chicago during the week of June 1 displayed a marked contrast to the first convention of that organization held at the same place just four years before. That first convention following the formation of the "Institute" after the inglorious dissolution of its predecessor, The National Electric Light Association, was a sad, serious affair; times, then, were dark, the electric load was down, though not a great amount, plant construction and manufacturing were at a standstill and a recent change in the national administration portended troublesome days ahead. The quietness of the situation, furthermore, was accentuated by the reverberations of certain holding company crashes which had scarcely died away.

Today, four years later, the outlook is considerably brighter—more hopeful. The electric load has not only gone up but has attained unprecedented heights and no end is in sight; power plant construction is in full swing, manufacturing establishments are working overtime and despite increased operating costs and higher taxes, profits are increasing; dividends, once more, are being paid. True, the threat of government competition and government control darken the picture and the forebodings of troublesome times which caused such dejection and apathy in 1933 are, perhaps, stronger than even then, but at the same time there exists a much more vigorous determination to fight these issues. As was the case at the convention in St. Louis last year, the attitude of resignation which prevailed several years ago has given way to a spirit of aggressive determination to fight for those rights which the Utilities claim as their own. It was but natural therefore that this convention should have been well attended. Registrations totaled close to 2000, a figure far short of the 5000 to 8000 that used to attend the famous Atlantic City gatherings of the N. E. L A., but still the largest attained since the reorganization under the new name. The list comprised most of the leaders of the utility interests throughout the country as well as important representatives of the principal electrical manufacturing establishments. There was Davidson of Nebraska Power, Owens of Oklahoma Gas and Electric, Kehoe of Consolidated Edison, Holtzclaw of Virginia Electric Power and Liversidge of Philadelphia Electric, all of them prominent for many years in the industry. There was dynamic and enthusiastic Philip Sporn, capable vice-president and tireless chief engineer of American Gas and Electric; genial Louis Egan of the Union Electric of Missouri, a disciple of Alex Dow and like Dow a fine operating executive; Mullendore of Southern California Edison, forceful defender of the industry and ardent protagonist of its virtues. And last, but not least, was Wendell Willkie, spokesman of the holding companies and the industry's outstanding front man, calm, eloquent and, as always, persuasive. Floyd Carlisle and the senior Thomas McCarter were absent but among those inconspicuously present—a mere name on the registration list, was Samuel Insul, Jr. To one who has followed the fortunes and growth of the electric utility industry over the major portion of its existence, it seemed ironical that with all the extolling of the industry's virtues the name of the man who did more to develop the growth of the industry than any one else, despite his shortcomings as a financial operator, should not even be mentioned. It is so easy to forget.

There were many sessions at which papers of interest to the members were presented, but the high point of the convention was the banquet in the Grand Ballroom of the Palmer House on Thursday evening. This was a splendid affair, attended by approximately a thousand members and guests, and replete with wine, entertainment and oratory. It was during this grand occasion that Frank W. Smith distinguished himself as a virtuoso upon the harmonica (mouth organ to you). Dr. Gus Dyer's address on the subject of Constitutional Regulations versus Governmental Dictations was received with great acclaim, though it served to demonstrate the limitations of present day amplifier and loud speaker design. Even 6L6 tubes, it seems, are no match for the peaks of Dr. Dyer's five kilowatt voice.

Despite the threats of political domination and government competition which many utility leaders feel confront the utility industry today, there was a notable lack of discussion of these issues at the business sessions. There were a number of papers, of course, which dealt with these phases of the industry, and on the whole these were vigorous and well founded, but the majority of the papers were devoted to problems of promoting new business, selling appliances, new developments and general education. In his presidential message to the Institute, Charles W. Kellogg dealt moderately with the political aspects and defended the practices of the industry and Bernard Weadock in a forceful address entitled "The Fourth Branch of the Government," berated the power and irresponsibility of various commissions, boards and administrations which exert so strong an influence in the national administration today. Dean Madden of New York University also presented a critical study of the Public Utility industry

Institute Meets at Chicago

which was strongly in its defense, but on the whole, considering the implied graveness of the situation, there was comparatively little public discussion of this aspect of the business.

In his presidential message, Mr. Kellogg stressed the fact that government propaganda has magnified the power issue out of all proportion to its relative economic importance. In sharp denial of charges aimed at the electric utility companies by Federal agencies, he pointed out that the electric bill is about two per cent of the average family budget, while taxes are about 14 times as large an item. The cost of raw power he said is a relatively small part of the cost of service to the vast majority of customers. "If power production cost nothing, rates for the average householder could be only slightly affected."

WE CAN point with pride to the public character not only of our service but of the information concerning our operations. If any industry in all the world does business in a glass house, it is this one with which we are connected. Not only our rates and charges, our receipts and expenditures, but all our investments, costs, salaries, wages, donations, contributions, losses and gains are spread upon the public records. Our customers have available to them as much information as do the owners of the properties, the stockholders. If there is any information concerning the details of the conduct of our business which the public does not have at its command, its omission can be charged only to the fact that no one has yet thought of it. What a misnomer it is to call our business "private".— W. C. Mullendore.

The Rural Electrification Administration, he said, further has attempted to make it appear that the utilities have tried to prevent the extension of electric service to the farms. Those in the industry knew that this was not true. On the contrary, he emphasized, the rural electrification movement was conceived and inaugurated by the utility companies themselves many years ago. However, unless farm service can be made to pay its own way, Mr. Kellogg said it is difficult to see how it can be continued in the long run. It is therefore necessary for the utility companies to seek greater uses of electricity on individual farms.

In his vigorous defense of the utilities, W. C. Mullendore, executive vice-president of the Southern California Edison Co., outlined the many splendid achievements of the electrical industry in an unusually effective manner. Today, he said, the industry's most severe if not its best informed critics display remarkable ability to ignore the true history of the electrical industry. "They would have the public understand," he pointed out, "that the service of electricity as it is known today is largely a gift of nature which has been appropriated by the public utilities . . . Those patrioteers who are so concerned to transfer this great natural resource to political management find it convenient to forget those who plan, build and maintain service in fair weather and in foul, through floods, and cyclones and earthquakes. The politician talks of God's free gift to the people, but does not mention those who, together with their predecessors, through the exercise of their own resourcefulness, enterprise and initiative have bridged that enormous gap between the crude dynamos of the early 80's and the great interconnected systems of today."

More specific in his criticism of political domination by government bodies was Bernard F. Weadock, managing director of the Institute, who attacked the many "headless" agencies, totally independent of any department which he said constituted a fourth branch of the government. "We find in these administrative agencies," he said, "persons of strong bias, prejudice and zeal seemingly desirous to extend their powers and advance their theories and schemes without reference to the mandates of the legislative branch nor respect for interpretations of the judicial branch of the Government.

Sporn, on Interconnection

So much for the addresses on the political aspects of the situation. Outstanding among the papers of technical and general interest was that presented by Philip Sporn of the American Gas and Electric Co. at the Wednesday morning session. This paper dealing with the general subject of interconnection would have been of interest in any event but coming from no less an authority than Mr. Sporn it carried with it all the weight and soundness that the long and successful experience of a man of Sporn's calibre could give it. In this presentation Mr. Sporn deplored to a certain extent the apparent lack of interest on the part of utility operators in the subject of interconnection, not so much from an engineering standpoint as from a philosophical standpoint. "There are many cases today," he said, "where interconnections might be made but no interconnections are being considered because people are now increasing capacity by putting in topping units." Topping or superposition is the style today, a fact which Sporn felt was unfortunate, not only in that fad or style has no business in the development of facilities of the utility systems but in that the overstressing of the cost element in generation always carries with it the danger that sight will be lost of the fact that cost of generation is a poor criterion of the cost of electric service. Mr. Sporn's view in this implies no criticism of the top plant as such, indeed his own system has installed tops wherever analysis shows them to be most useful, but it does bemoan their indiscriminate use.

Interconnection, Mr. Sporn pointed out is an old subject, one which for a long time was linked with the loosely used term "superpower." The era of super-

power seems to have definitely disappeared and nobody regrets its passing but the disappearance of discussion and lack of interest in the subject of interconnection is less understandable. "Basically," according to Sporn, "interconnection of utility systems involves the idea of so operating the component parts of a system or group of systems that under all conditions, generation and transmission are accomplished in the most efficient manner. The idea behind interconnection postulates the idea of mutual help and of mutual support in time of need, without stint, up to the limit where the helper himself is jeopardized. In some cases where all the instrumentalities for interconnection are available, no true interconnection exists because those responsible for the planning and operation of the system have not really been converted to the idea of interconnection. They merely play with the idea and inwardly they are afraid that if they operate interconnected they will subject themselves to, and will have to share other people's troubles. Before the physical advantages of interconnection can be fully realized, it is necessary to definitely embrace a philosophy of operating interconnected. As far as the technique of interconnection is concerned, that, said Mr. Sporn, entails no difficulties incapable of solution, it is highly developed and is being more closely perfected every day.

To bear out his contentions regarding the value of interconnection Mr. Sporn related a number of instances on his own system where interconnection had proved of inestimable value.

Aside from the natural advantages to be obtained from interconnection, Mr. Sporn implied that if the utility companies did not avail themselves of the opportunities existing in this direction, they might be compelled to do so under the requirements of the Public Utility Act.

Dr. Morris Fishbein on Education and Light

Those who knew or had heard Dr. Morris Fishbein before needed no assurance that his address on Education and Light at the first session of the meeting would be interesting and amusing. For this chief spokesman for the medical profession has a manner, a refreshing sense of humor and a popular appeal that has fascinated audiences of all characters from one end of the nation to the other. Dr. Fishbein has the common touch—his sayings interest the erudite and the plain alike and what he has to say is always timely and to the point. His flare for debunking and exposing medical fallacies have done as much for the medical profession and for the nation as a whole as the work of the most distinguished doctors and surgeons.

As the direct representative of the medical profession and as editor of the Journal of the American Medical Association, Dr. Fishbein was well qualified to address the convention on the relation between education and light, and his remarks gave new impetus and significance to the Better Light, Better Sight campaign of the utilities. Dr. Fishbein stressed the necessity of adequate and proper light in promoting better vision. His comments on the relation of the speed of reading to the degree of illumination were exceedingly interesting. There are, of course, many factors that influence the speed of reading but illumination is a very important one. Just as soon as the illumination becomes inadequate, the speed of reading decreases correspondingly. An average person said Dr. Fishbein can grasp three or four words at a glance. An expert reader like President Roosevelt or former President Theodore Roosevelt may read from one-half page to a page at a glance. A good reader reads fast because he has a good mind. Your eyes will not move faster than your mind can move. The intelligent person may read three to ten words a second which is from 180 to 600 words a minute, but it requires an extraordinary reader to read as much as 300 words a minute for more than three or four minutes. Most people, said Dr. Fishbein, think that a fast reader does not retain as much as a slow reader. Actually an examination made on college students shows that a fast reader can reproduce 37 per cent more of what he reads than can a slow reader. People who move their lips when they read, read more slowly and think as fast as they read. In any case, however, as soon as the illumination becomes inadequate the speed of reading decreases correspondingly.

In manufacturing industries, naturally the degree of illumination not only influences the speed of the workers but also the number of errors and accidents. In the Chicago postoffice, when the illumination was moved up from 3 foot candles to 11 foot candles, the amount of work increased 8 per cent with fewer errors.

Studies at Johns Hopkins, Dr. Fishbein pointed out further, showed that the aged eye requires more illumination for good vision than does the young eye. The eye of a person 63 yr. old can be made to have, at 60 ft. candle, an ability to see that is possessed by eyes of younger people at 5 foot candles.

Appliance Sales, Servicing, Home Service, Etc.

In marked contrast to such addresses by Philip Sporn, Dr Fishbein and others of a like nature were those addresses dealing with problems of a commercial character, selling, servicing of appliances, home service and the use of electricity in the home. There were a number of such papers. One of the most interesting of these was one by Walter Forbush, vice president of the Edison Electric Illuminating Co. of Brockton, Mass., in which he discussed the factors responsible for the rapid electrification of homes in conservative New England. Most important of these factors, he said, is the community friendliness and belief in the honesty and sincerity of the company which has developed during the years it was established. Miss Nancy Finch, of the Utah Power and Light Co., presented an interesting discussion on What Women Can Do to Increase the Use of Electric Service in which she outlined the work done by her own organization. Earl W. Gray of Oklahoma Gas and Electric Co. outlined the opportunities and problems of Conditioned Air. In concluding this paper in which he considered all the various phases of air conditioning he stated that air conditioning sales during 1936 amounted to $43,000,000 and that annual sales of $350,000,000 were predicted by 1945. This, he said, would amount to an additional load of some 5,000,000 hp. and an additional revenue of $100,000,000 annually.

Many of these papers, naturally reviewed facts known to those in the industry but repetition is always effective and a slightly different point of view often provides new inspiration. C. E. Wilson's address on the Electrical Standard of Living, for example, emphasized the importance of the electrical industry in the

lives of the people and served to make those in the industry more conscious of their responsibilities. Similarly, H. P. Liversidge's paper on Opportunities for Youth in the Electric Industry, pointed to much that still remained to be accomplished in the future. In the matter of power generation from fuel for example, he pointed to our more or less general acceptance of the fact that only 30 per cent of the energy in the fuel is utilized. Despite the fact that many may consider this 70 per cent loss inevitable, he said that sooner or later many young engineers would accept the challenge which this problem implies and that it would be solved.

The paper on Selling by J. F. Porter, Jr., of the Kansas City Power and Light Co. was somewhat elementary in its import and it did not seem that the ideas on selling appliances which he presented could have been anything but self-evident to most of those present. It seemed rather unnecessary to devote the better part of an hour to the task impressing an audience of intelligent executives and engineers with selling facts which to say the least must be obvious to even a prospective customer. The demonstration of a typical sales talk with an actual refrigerator was rather childish, considering the character of the audience.

Research

Of far greater significance were the addresses by Dr. L. W. Chubb, Director of Research of Westinghouse, and R. C. Muir of General Electric, on Wednesday and Friday respectively.

Dr. Chubb discussed some of the new products from research in the electrical industry, while Mr. Muir considered some of the engineering contributions to society. Both of these papers were extremely interesting, particularly the former because of actual demonstrations of research products on the stage. Although Dr. Chubb's introductory remarks were on research in general, the major portion of his address was devoted to a discussion and demonstration of three new products, the first, a new electrostatic air cleaner, the second, what he called "Polyphase Light," which was really a demonstration of the use of polarized light for new purposes, and finally, a third product popularly known as the "Atom Smasher."

The first, that is, the air cleaner, was a small, compact, electrostatic precipitator used to remove particles from air subsequently to be used for breathing. The demonstration model was provided with a "pipe" for producing tobacco smoke. This smoke was drawn through the small glass enclosed precipitator by a fan. As long as the voltage was off, the smoke passed completely through the device, but the instant the voltage was applied, the smoke disappeared. This air cleaner, said Dr. Chubb, has wide application, in homes, schools, factories and office buildings. The first large installation is now being made at the Field Building in Chicago.

Dr. Chubb's second demonstration was of the use of Polaroid screens in producing various and beautiful color effects, suggestive of new possibilities in the lighting field, while his third topic which by virtue of its nature precluded demonstration was the new 5,000,000 v. equipment being built at the Westinghouse plant at Pittsburgh for conducting experiments in the field of nuclear physics. This equipment, an artists' conception of which is shown on p. 388 of this issue consists of a huge pear shaped tank 30 ft. in diameter and 47 ft. high housing an electro-static direct current generator and a 40 ft. vacuum tube. Under a direct potential of 5,000,000 volts this equipment will accelerate particles—electrons, protons, deuterons to a speed of 100 million miles per hour for use as projectiles in penetrating the atom.

This, said Dr. Chubb is a good example of pure research at present it has no practical value and nobody knows where the work will lead, but it has hidden in it "golden nuggets of scientific opportunity."

Muir on Progress

So much for Dr. Chubb's paper. Mr. Muir's paper was quite different in that it did not deal with research directly but rather in the effect of research and development in the improvement of equipment methods and devices used in the industry. Beginning with a discussion of what has been achieved in the way of thermal efficiency during the past 15 yr., he reviewed the improvement in all elements of the electric generating plant as well as in the transmission and distribution system and finally in the design and manufacture of electrical appliances. As an outstanding example of the value of engineering research in effecting a more economical use of materials and greater economy of operation, Mr. Muir cited the use of hydrogen as a cooling element for rotating machines. With hydrogen, 25 per cent greater output may be obtained from a machine of given physical dimensions. In the past 8 yr. 17 hydrogen cooled machines, with a combined capacity of nearly ½ million kv-a. have been placed in service. Another notable achievement, he showed, are the 287,000 v. impulse type circuit breakers which require only 2300 gal. of oil compared to 23,700 gal. in a conventional oil circuit breaker. Similar improvement, he pointed out, had been made in the appliance field, in refrigerators, radio receivers, washing machines, etc. His lantern slides showing comparisons between old and modern equipment of this kind were startling.

W. E. Mitchell's address entitled "Safety Pays Big Dividends" was another very interesting paper. Mr. Mitchell is vice-president and general manager of the Georgia Power Co. and his attitude in regard to the promotion of safety measures is admirable. It is good business, he insists, to consider the employes' health and safety and if properly handled pays big dividends. He cited instances where the Georgia Power Co. had spent as much as $25,000 in paying for doctors' bills and hospital services of an electrician who had been severely injured while on duty.

In this report we have been able only to just touch upon the topics of the papers presented, but the material presented here will give one a fair picture of their general character. On the whole they were of considerable general interest and well diversified. Considering the fact that these E. E. I. conventions are attended largely by executives, the papers were well selected, though an engineer might regret the absence of the many fine technical papers and discussions that used to characterize the old N. E. L. A. conventions.

The convention was concluded on Friday morning, June 4th, with the presentation of awards and introductions and installation of officers. The Coffin Award won by the Consolidated Edison Co. of New York was received by John C. Parker.

No factor in the operation of direct current rotating machinery is more important than brush operation. Some brush troubles are easy to overcome but others are quite mysterious and difficult to solve. In this article the author presents a number of interesting and unusual brush troubles.

Unusual Brush Troubles

By L. L. STOFFEL

Chief Engineer, The Ohio Carbon Co.

PROBABLY more than 90 per cent of the troubles encountered in motor and generator brushes are the regular "run-of-mine" stuff which every maintenance engineer can easily diagnose and cure. Now and then, however, "freak" troubles of excessive wear, sparking, etc., turn up and seem to defy analysis.

For instance, a direct current motor had been sent out for repairs. The commutator sleeve insulation had developed a bad ground, and the armature had burned out in consequence. When the machine was re-installed, violent and persistent sparking occurred, and this was not curable by any amount of brush rocker adjustment or re-bedding of brushes. Investigations proved that owing to an error in the spacing of the "bar-to-bar" connections on the commutator the brush spacing could not be made to correspond with the neutral positions on the armature.

Starter Improperly Connected

Another curious trouble, also met with immediately after disconnecting the machine for repairs, produced the effect of the motor refusing to start if loaded; sparking violently under all starting conditions; and, if started on light load, of taking a very heavy current and running up to an excessive speed before the starting switch could be brought to the running position. The diagram herewith shows what had occurred —the starter was connected up wrongly, so that the field circuit was short-circuited as the running position was approached. This trouble of course would only be likely to occur on a small motor in which the starter wires would all be about the same diameter and could thus be easily transposed by mistake.

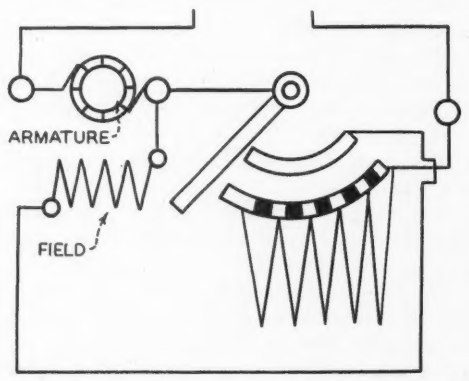


Fig. 1. Diagram of wrongly-connected starter which caused bad sparking. Note that the starter arm short-circuits the field as it approaches the running position

Mixing Brushes

A motor user ordered a new set of brushes for a direct current machine. These were of somewhat different grade to those formerly used—the idea being to find out if a more abrasive quality would help to keep the commutator clean under excessively adverse dirt conditions. Considerable sparking and rapid wear were complained of, the new brushes being stated to be wearing down every few days. This trouble proved to be due to the fact that the user tried to compare the relative performance of the old and the new brushes by fitting both old and new together on the same brush studs. But since the resistances of the two grades happened to differ slightly the new brushes, (which had the lower resistance), naturally took far more than their rightful share of the load—hence the sparking and wear complained of. Different grades of branches should never be mixed on the same machine. Two separate tests should have been made—one with the machine completely equipped with the old and the other with the new type only. So important is it that brushes which run together should have the same resistance that for some motors and generators whose electrical balance is very "critical" it is customary to make all brushes of a set from the same "mix".

Overloading brushes is a sure way to wear them out quickly, and to cause heating and sparking. This is particularly true of the metal-graphite brushes used on electroplating generators. One curious case of this kind shows how necessary it is to take nothing for

granted when investigating brush troubles. The brushes of a large plating generator sparked excessively and wore out so fast that they had to be replaced every week or so. The machine was apparently overloaded, because the armature was hot all over, but there was no sign of short-circuited armature coils. The plating tank ammeters did not, however, indicate that any excessive current was being taken. The fault was eventually traced to the wooden frames which supported the main busbars between the generator and the tanks. These frames, although apparently all right, were actually so soaked with acid fumes that they practically short-circuited the busbars themselves. Naturally the tank ammeters did not show this, and there was no main ammeter between the generator and the busbars.

Another case of plating generator trouble showed excessive sparking and undue wear; and the armature, although hot all over, did not seem to be overloaded even though there was a main ammeter in circuit. The machine was badly neglected and dirty, and the metal-graphite dust had been allowed to accumulate into a mass piled up against the "heels" of the brushes. The result therefore was that the effective collecting area of the brushes was somewhat longer across their "toe-to-heel" dimension than it should have been. This caused too many commutator bars to be bridged at one

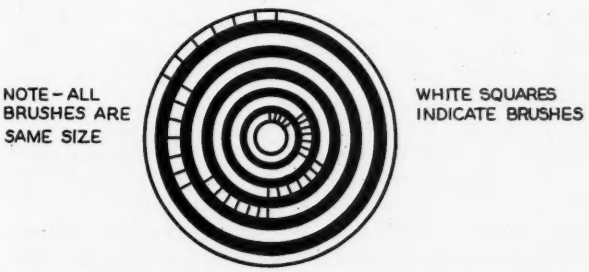


Fig. 2. Suggested arrangement of brushes on a six-phase rotary converter so as to avoid unequal wear on alternate ring sections

time. Moral: Keep dust and dirt out of your machines and most of your troubles will disappear.

In yet another case, an "old-timer" plating machine originally equipped with copper-gauze brushes, had been converted to metal-graphite brushes. Both the commutator and the brushes were badly worn, and sparking was in evidence when loaded. No amount of re-bedding of the brushes or adjustment of brush rocker could effect a cure. The reason was that the commutator dimensions had been calculated for copper-gauze brushes, which carry a considerable current; whereas metal-graphite brushes have a much lower conductivity. The latter therefore heated up and wore out quickly, and at the same time did not commutate satisfactorily. Moreover, it was found impossible to find room for the extra brush surface necessary after the conversion; and it would have been considerably cheaper to junk the entire machine and to install one which was designed to take metal-graphite brushes.

Low-voltage generators of the "Double-commutator" type are subject to another peculiarly exasperating trouble. Unless both sets of brushes are set exactly at the proper neutral positions one commutator tends to "hog" most of the load, and its brushes will spark badly. Adjusting the brush rocker will generally cure the trouble on that particular commutator, but since both windings are on a common armature any variation of brush setting on one of them may easily affect the neutral position of the other. Sparking may thus be started on the other commutator which did not spark before. The best way to cure this is to take the load entirely off one commutator and adjust its rocker; then to do the same with the other; and finally to apply full load to both commutators, making final adjustments if necessary. With modern plating generators having interpoles, the last-named test is unnecessary, since the neutral position is fixed anyway.

Flat spots and burns on alternating current slip-ring motors may be due to heavy starting current, bad brush bedding, or soft ring material, etc. Corrosion due to chemical fumes is also a fruitful cause of "flats". Sparking and wear from this cause may often be corrected by using somewhat more abrasive brushes, since it is the heavy coating of oxide which starts the trouble. A much less usual form of deterioration, however, is known as "copper-picking" and is met with as a rule on revolving field alternators. In these the rings are of course fed with direct current. Particularly if sparking takes place, there is a tendency for metal from the rings to be torn out of them and imbedded firmly in the under-surface of the negative pole brushes. Thus the negative ring appears pitted and burnt, while the positive ring assumes a dark copper-color and is comparatively uninjured on the running surface. Fortunately the cure is easy. After smoothing the negative ring by re-turning or re-grinding, merely reverse the position and negative connections to the brush studs every few weeks.

Converter Brush Troubles

Brush and ring troubles sometimes take queer forms on rotary converters. One of these forms is that of excessive wear and "picking" on alternate sections of each of the rings. It is evident that if the metal-transfer effect is to be neutralized and the ring-wear equalized all over each ring, current must flow to and from every part of each ring. This means that the brushes from any given ring must be so spaced around its circumference that this result may be attained. In some cases, however, all the brushes of one phase are mounted on the same stud. If now the converter is a four-pole one, it will be seen that during one quarter of a revolution the current will flow from brush to ring and that during the successive quarter-revolution the flow will be in the reverse direction; thus causing excessive wear on alternate quarters. The accompanying drawing shows one excellent brush-spacing arrangement for a six-phase rotary converter.

Installed cost of equipment sold by the members of the Air Conditioning Manufacturers' Association broke all records in the first four months of 1937, aggregating $41,311,301, increase of 180 per cent over the sales of $14,756,992 in the same months a year ago, and a total not reached in 1936 until October, according to announcement by William B. Henderson, executive vice-president. April sales were second highest of any month in history, being $9,663,009, an increase of 156.8 per cent over the April, 1936, total, which was $3,751,015.

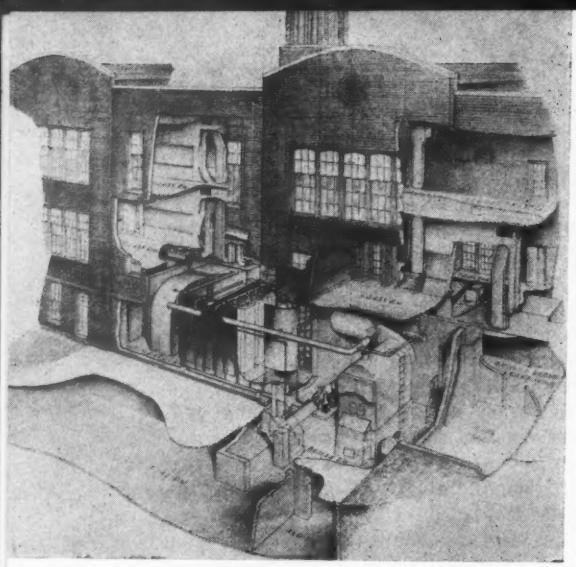


Fig. 1. Perspective drawing of the Herzog School Heating and Ventilating system

Automatic Temperature Control Grows in Popularity

Peter Herzog School in St. Louis Incorporates Complete Temperature Control

ONE OF THE INTERESTING heating and ventilating installations of recent months is in the Peter Herzog School, St. Louis, Mo. This is not a large school but the complete automatic control provided is worthy of detailed study. With this system ventilation is constant, there being no change in amount of air delivered. Maximum heating is provided when outdoor dry bulb temperature and solar radiation effect drop, and wind velocity increases. The necessary cooling is provided through 65 deg. F. plenum air when occupancy and sun load build up in various rooms.

The St. Louis Board of Education has always been unusually progressive, especially so in connection with mechanical systems, and the new Southwest High School now nearing completion will incorporate, on a larger scale, fundamentally the same control system provided at Herzog. Electric power is purchased in both schools. George W. Sanger, now Commissioner of School Buildings, was architect; J. L. Carlisle, formerly Division Engineer of Department of Public Utilities of the city of St. Louis, is now Chief Engineer of the Board of Education, and Gus Eversohl is custodian of Herzog School.

At Herzog steam for heating is provided by a Brownell 160 hp. low pressure firebox boiler fired by a St. Louis stoker. Coal burned is a 1¼ in. Illinois screenings running about 10,500 B.t.u. per lb. as fired. The heating system is a two pipe vacuum system of the blast type with some direct radiation in a few rooms.

Arrangements of the equipment and ducts are shown by the illustration. In general, air is drawn from the outside through a stack economizer, where the cold air is heated by the bare metal stack. Leaving the economizer this air passes through Libby-Owen air filter sections through the tempering coils, air washer and heating coils to a central supply fan for delivery to a plenum chamber incorporated as part of the first floor corridor ceiling. Ducts from the plenum chamber are provided with booster heaters. Air enters the respective room at the top and leaves through registers in the wardrobes.

Tempering coils are arranged in two banks of four units, each unit with 760 sq. ft. of heating surface made up of 10 ft. tubes. Heating coils are arranged in a single bank of four 1308 sq. ft. units each. By-pass dampers are provided between the tempering and heating coil units. Booster units have two rows of 2 ft. tubes giving 93 and 140 sq. ft. All of these coils are Modine.

Water for the Buffalo spray type air washer is supplied by a 350 g.p.m. Buffalo motor driven centrifugal pump. The main fan is a 50,000 c.f.m. Buffalo, driven by a two speed induction motor. The temperature regulation system and apparatus is by the Minneapolis-Honeywell Reg. Co.

When the system is shut down the fresh air and exhaust dampers and air washer spray valve are closed, recirculation dampers are open and the signal light off. For morning heat-up period the central fan is manually started and this energizes relays to open fresh air dampers; places air washer spray valve under command of the controller; places recirculation and exhaust dampers under control of a thermostat by energizing relays, and holds heating coil valves wide open and by-pass dampers closed.

When the desired room temperature (normally 68 deg. F.) is reached a thermostat turns on a signal light on the temperature control panel board, opens exhaust dampers and closes recirculating dampers and places modulating heating coil valves and by-pass dampers under automatic control to maintain a plenum air temperature of 65 deg. F.

Signal light indicates to custodian that the building is up to temperature and that 100 per cent fresh air will be provided within 2 min. (after light turns on) and thus producing additional boiler load.

When the outdoor air temperature is above 35 deg. F., recirculated air washer water is delivered by a pump through the washer under command of a controller. Dewpoint control of washer water is obtained through a modulating step controller and compensated for correct humidity by a compensator.

In order to prevent overhumidification when incoming air temperature drops to 35 deg. F., air washer sprays are shut down by a controller, but the flooding nozzles continue to function. At this time another controller opens two-position valves which remain open as long as incoming air temperature remains below 35 deg. F.

Booster coil modulating valves are controlled by individual thermostats to maintain 70 deg. F. room temperature. In the Principal's and Doctor's offices direct radiation as well as booster coils are under command of thermostats to open direct radiator valves when plant is shut down after school and temperature drops to 69 deg. F., thus utilizing steam left in mains. Direct radiation in toilet rooms is under control of thermostats and two position radiator valves.

Soldering Pipe Threads To Prevent Oil Leaks

By
WM. J. HART

Mechanical Engineer, Sharon Wks.
Westinghouse Electric & Mfg. Co.

FOR MANY YEARS vessels required to hold oil in service have been more or less subjected to oil seepage or sweating. When continual dripping is evident, an effort is usually made to correct the cause before waste is excessive; however, slight seepage and sweating is often tolerated because not much oil is lost. In the modern transformer tank filled with the conventional or non-explosive oils, every effort is made to make the welds, gaskets and screwed fittings oil-tight. One drop of oil, due to capillary action, will spread in all directions until it covers a large area of the wall; this is a condition which is not only unsightly in appearance but it permits dust to collect and in some locations it might be considered a fire hazard.

Since it is necessary to have screwed fittings for valves, gages and attachments, special attention must be given to these joints. For simplicity most screwed fittings on tank walls are nipples which are threaded first and then welded directly to the walls, the nipple being concentric with the accommodating punched hole. Due to the close proximity of the weld to the thread, a certain amount of distortion of the thread takes place from the heat of welding. An effort to reshape the threads with a die is sometimes effective; however, it requires a great deal of hand labor and time to correct the distortion completely and, with large sizes of pipe threads, it is practically impossible on account of the excessive torque required by hand.

Assuming that a perfect thread has been made there is a possibility of leaks occurring when the valve or gage is screwed on the nipple due to the fact that the fittings usually require some alignment and, when the valve or gage is screwed to a point where it might be tight, there is a possibility that it has gone beyond its normal alignment. In this case, if an attempt is made to tighten it further to secure alignment, there is danger of breaking the nipple and if it is backed off to secure the alignment, it will be loose and leak oil.

This dilemma is overcome with the following procedure: The pipe nipple is threaded in the usual manner; if the distance between the thread and the weld is not to close, the thread can be tinned with a low melting solder before it is welded to the wall; if, however, it is too close it can be tinned after welding to the tank. This distance can best be determined by selecting a common solder and tinning a test piece first, then ascertaining how close the welding can be done without causing the solder to flow. It is more economical to solder the nipple before it is welded to the tank because it is often difficult to place a large tank in a position which permits applying the solder conveniently after the nipple has been welded to it. Tinning with solder, in most cases, is not a difficult task provided the heat required to tin such appurtenances does not cause distortion and damage. In this method of producing the soldered joint, both male and female threads must be tinned and then screwed together until proper alignment is secured. The alignment of the fitting therefore can be determined much easier as it is not necessary to have the fittings real tight. When the final screwed joint is heated to apply the fillet, any void or gap in the thread is easily melted and forms a solid seal. This final tinning is accomplished with the oxy-acetylene torch and a solder stick. The fillet produces the appearance of a "plumbers wiped joint" and seals off any tendency for oil to seep through.

Fig. 1. Tinning the thread with low melting solder
Fig. 2. Screwing the valve in place while heating with the blow torch

Steel Point Adds 5000-kw. Top

(Continued from page 396)

ing feedwater heater. To assure practically zero oxygen sodium sulphite is introduced in the high pressure feedwater system between the deaerating heater and the high pressure feedwater pumps.

The control of proper water conditions includes the training of station operators in methods of testing and recording results in order to obtain the best possible feedwater treatment.

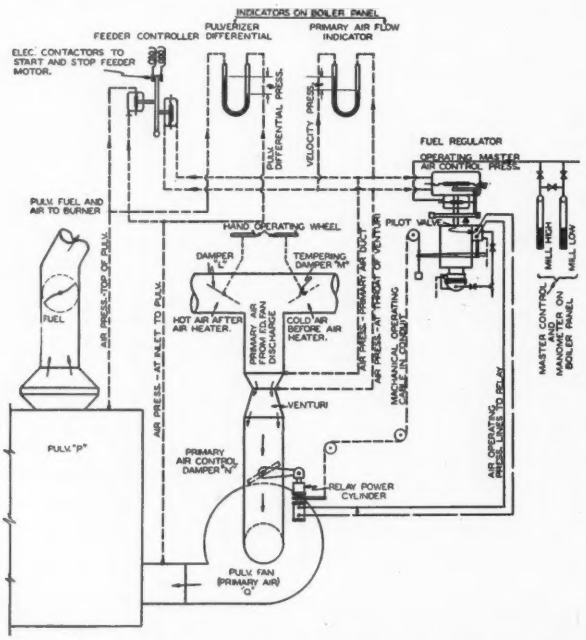


Fig. 7. Detail of connections of the fuel feed regulator.

The equipment for treatment is installed in a separate room on the first floor of the boiler room for mixing and pumping chemicals to the low pressure feedwater heaters. The equipment includes a chemical solution tank, piping and pump. The solution tank is designed so that each inch in depth represents 5 gal. of solution. The tank is equipped with an adjustable mixing basket. The piping between the solution tank and the pump includes, in addition to the necessary valves, a special solenoid valve controlled by a time switch which automatically alternates the flow of solution and flushing water to the chemical pump. The chemical pump is operated by the same time switch that operates the solenoid valve. This switch starts and stops the pump by a time-cycle repeat method so that it pumps the solution to the heaters for a predetermined time each hour. It next flushes the chemical solution piping between the solenoid valve and the heaters.

From the discharge side of the pump the chemical piping connects to a 1-in. header and then to individual branches each fitted with an orifice opening 0.2 in. in diameter to allow an even distribution of the solution to any combination of the four low pressure heaters that may be in use. In the heaters the solution is mixed with the feedwater and it is then distributed through the feedwater system to both low and high pressure boilers furnishing feedwater directly to the 225 lb. boilers and also to the 625 lb. boilers through the high pressure heater.

The timer which controls the solenoid valve has a time cycle of 60 min. with one fixed and one adjustable cam each controlling a switch, both contacts normally open and both arranged to close simultaneously. The purpose of the time switch is to control the position of the solenoid valve for passing either chemical solution or flushing water and to start and stop the motor operating the chemical solution pump in accordance with the time cycle for which it is set.

Hot and cold water are provided for the chemical solution tank. The best temperature for dissolving the phosphate is 90 to 100 deg. F.

Provision for introducing sodium sulphite is made only in the high pressure system. Sodium sulphite is used to assure zero oxygen in the feedwater to the high pressure boilers and is merely a precaution in addition to the oxygen removal feature of the deaerating heater. To feed the sulphite a "sulphite pot" is installed between the deaerator and the high pressure feed pumps. The top of the pot is connected to the feedwater header of the 225 lb. boilers. The bottom of the pot is connected through a needle valve to the outlet piping from the deaerator. The difference in pressure between these points of connection causes the sulphite solution to be fed into the inlet of the high pressure boiler feed pumps. Provision is made to shut off this system so that the sulphite solution may be added to the pot and for draining it without interrupting the operation of the feedwater system.

The 5000 kw. Turbine-Generator

The high pressure turbine generator consists of a 5000-kw. 9-stage turbine designed for 600 lb. gage initial steam pressure with 740 to 840 deg. F. initial steam temperature, depending upon the load, and exhausting to the steam header supplying steam to the present condensing turbine generators. The generator is a 3 phase, 60 cycle, 2 pole, 6250-kv-a., 80 per cent power factor, 6900 volt machine with a direct-connected exciter and operating at 3600 r.p.m.

Under all conditions of load on this turbine the throttle pressure is maintained at approximately 610 lb. When operating on "back pressure control," the load on this turbine is regulated entirely by the back pressure in its exhaust line. However, the present method of operation involves manual readjustment of the back pressure governor to secure the desired load and back pressure conditions. Without manual adjustment, the exhaust pressure varies through a range of 6 lb. per sq. in. from no load to full load.

To allow the high pressure boilers to generate more steam and to allow the 5000-kw. unit to generate more load, the combustion control on the stoker fired boilers is set so as not to demand more steam from them until the pressure drops markedly at the control point.

Instruments

A complete set of instruments is provided for the control and operation of this new unit. Most of the instruments and controls have been brought to a few

central control panels so that the work of the operators is simplified. These panels are known as the Boiler, Turbine, Feedwater, and Desuperheater Panels.

There are two boiler panels, one for each of the 625 lb. boilers. Except that the panel for No. 12 boiler carries the pressure control element and the panel for No. 11 boiler contains a wattmeter indicating the load on No. 8 turbine, the panels are alike in the equipment carried on them. These instruments include pulverizer ammeters, master combustion controller, locking switch, feeder control throw-over switch, feeder controls with indicating lamps, pressure control element and push button stations for fans, feeders and pulverizers.

Each panel carries a multi-pointer gage which gives 14 indications of the operation of its boiler. They are rate of steam flow, boiler drum pressure, feedwater pressure, per cent CO_2, forced draft fan pressure, hot air duct pressure, burner box pressure, furnace draft, boiler exit draft, induced draft fan suction, pulverized differential and primary air flow, the two last appearing twice on each panel, once for each pulverizer. Since certain operations are of great importance they are permanently recorded. A strip chart recorder on each panel is furnished with 6 pens which give a permanent record of steam flow, per cent CO_2, gas temperature entering air heater, gas temperature leaving air heater, air temperature leaving air heater and steam temperature.

A steam flow integrator measures the steam output of each boiler and supplements the reading given by the steam flow pointer pen.

Turbine Panel

The instrument panel for No. 8 turbine includes the instruments and control for the desuperheater in the turbine-exhaust line as well as those more particularly applying to the turbine itself. Two instruments on this panel apply to the generator electrical output, an indicating wattmeter and a frequency meter. Two indicating pressure gages show the pressures of the steam as it enters and leaves the turbine. There are 3 indicating thermometers for air temperature at the outlet of the generator air cooler and for temperatures of steam going into and out of the turbine. A 2-pin pressure recorder makes the record of entering and leaving turbine steam pressures, on another instrument a pen draws a record of steam flow to the turbine, and the temperature of steam beyond the desuperheater in the exhaust line is recorded as part of the desuperheater control system. Finally there is an integrator for adding up the weight of steam used by the turbine. Again, it will be noted that especially important indications are recorded on charts.

Feedwater Panel

The feedwater panel is located conveniently near the high pressure feed pumps and carries three pressure gages which show pressure in the deaerating heater, feed pump suction pressure and feed pump discharge pressure, the latter two being taken in the respective headers. A two pen pressure recorder takes care of the discharge pressures of the present 260 lb. pumps and of the new 800 lb. pumps on one chart. Another two pen recorder keeps track of the temperatures of the feedwater as it enters and leaves the deaerating heater. The flow of feedwater is recorded on a third chart and integrated by the usual type of instrument. Finally, there is a start and stop push button station on this panel for each 800 lb. boiler feed pump.

Desuperheater Panels

Of the six desuperheaters in the station, one has volumetric control and five have temperature control. The volumetric control desuperheater is in the turbine by-pass line and does not require an instrument panel. The others do need such panels, although in the case of the exhaust line desuperheater, this has been combined with the turbine panel. The two desuperheaters in the auxiliary lines have a combined panel at a convenient central location, while each of the two remaining desuperheaters (in No. 1 and 2 turbine leads) has its own separate panel. These variations are in arrangement only for the five sets of controls and instruments are practically identical. On all of these panels a continuous record is made of the steam temperature leaving each desuperheater and a system of alarms is provided involving lights and horns which warn the operators of both high and low steam temperatures.

Flow Meters

There are four flow meters in the new part of the station, one to measure the steam flow from each boiler, one to measure the steam flow to the turbine, and one for the flow of feedwater to the boilers.

Electrical Features of the Installation

In addition to the provision of new control and switching equipment for controlling the output of the new 5000-kw. generator and its exciter a complete electrical auxiliary control system was involved. This included a 2300 v. metal clad switchboard in a special room on the first floor of the boiler house, a 460 v. air circuit breaker switchboard on an upper floor in the boiler house, new lighting panels, a 120 v., 60 cell storage battery, electrical equipment for the Cottrell precipitator and other miscellaneous equipment.

Conclusion

The foregoing covers the principal and most important features of this new installation. We have gone into considerable detail in describing many of these features not only because they are well designed but all of them together give one an idea of how completely everything in this station has been worked out and co-ordinated with the existing equipment. The superposition of a unit of this kind involves problems that are not encountered in the design of a completely new station and in this particular case they have been met with unusual success.

In closing we wish to express our appreciation to Westcott and Mapes, Inc., of New Haven, Conn., who designed and built the station, for furnishing the material upon which this article is based, and to Oscar Richmond, the chief engineer of Steel Point Station, for courtesies shown to the editors in visiting the station.

Remedies for Furnace Explosions

By C. C. CUSTER

IN POWER PLANT ENGINEERING a few months ago I noted a well written article by P. F. Rogers on "Furnace Explosions." This class of hazard can not be obviated completely by correct furnace design, it is an ever-present hazard no matter what the fuel nor whether the firing is done by hand, by stoker or by auto-burners handling gas or oil. The best solution is to understand fully just how these accidents come about and to avoid the cause. Hazards do not always mean serious danger; some classes of hazards need but to be known to be easily avoided, or to be cured by inexpensive precautions.

There are four major hazards connected with the burning of fuel: namely fire hazard, explosion hazard, poisoning by carbon-monoxide, and asphyxiation by carbon dioxide. These hazards are all more or less related and many such accidents are samples of what the French would call "being hoist with one's own petard":—that is, being injured by a happening for which they themselves are primarily responsible. Several cases might be mentioned:

(A) The old lady who thought she smelled a dead rat in the cellar and went to look for it with a lighted candle. It was escaping artificial gas. She found it. (B) A colored man standing on the street corner was attracted by several rats painfully crawling from a storm sewer catch basin. He went near and struck a match to see what was driving out the rats. There had been a leak in an underground gas main which found its way to the catch basin and when the match was lit it set off the gas, blew off the man-hole cover and threw the much surprised negro over against the fence. Of course if the presence of any kind of gas is suspected it is folly to go looking for it with an open flame. A flash light is much safer. Besides being ignited by an open flame, there are two more ways in which gas mixtures may be set off; by an increase in temperature, and by a sudden accession of air. Whether the gas burns with a flame or an explosion depends on how much it is mixed with air. The condition favorable to an explosion is nine parts air to one of gas.

Oil on Hot Coals

Let us note several cases: (C) A man had a small bucket of dirty oil of which he wanted to dispose. He opened the furnace door and dashed it in on the fire, it back-fired and scorched his whiskers and eyebrows. In this case the gas burned with a flame just as fast as it was generated. (D) A young man who was operating a small electric light plant went to look at the fire under his boiler and was surprised to find only a few red coals and fire nearly out. With darkness rapidly approaching he would soon have to turn on the lights. In an effort to kindle the fire quickly, he threw a large bucket of dirty engine oil on the coals which almost quenched the fire and did not set fire to the large volume of gas generated but the neighbors called and told him his chimney was burning out. Going outside he saw a sheet of flame coming out of top of stack that looked like a blast furnace in operation. In this case the gas did not ignite till it reached the air and got its quota of oxygen.

(E) In most cases of furnace explosions that I have investigated, the contributing cause has been improper banking of fires on the part of the attendant. Some people sometimes get the idea that to bank a fire one must distribute the hot coals over the grate, then cover entirely over the top with fine coal, blanking the fire entirely off, then shut off the draft in front and open the check draft at rear of boiler. Gas is rapidly distilled off the fresh coal and, without an igniting flame, it collects in the setting and sometimes is ignited just as the rear check draft is opened or the explosion happens about 5 min. after the attendant has left the boiler room. This method of banking is usually the cause of furnace explosions in locomotive firebox types of heating boilers. This same thing often occurs when the fire is banked off in the same type of boiler by attempting to burn garbage on top of the fuel bed.

Ordinary semi-bituminous coal contains about 64 per cent of fixed carbon and about 30 per cent of volatile hydro-carbons. When banking a fire with this kind of coal it is imperative that some flame be allowed to break through to burn the gas above the bank and the over fire draft should not be cut down too much until a sufficient time has elapsed to drive off most of its volatile content and the fuel approaches the coking stage. This implies that a later trip should be made to a heating boiler to cut down the draft for the night.

With coal stokers of the intermittent auto-control type, I find furnace explosions are sometimes caused by spacing the operating periods too far apart or by having the draft of air supply too nearly closed at the down periods. Then when the apparatus starts up some gas that has accumulated in the setting ignites. I also ran down some obscure cases of stoker furnace explosions and found they occurred just after the grates had been cleaned. The coal used was high in sulphur and iron pyrite content, and clinkers were formed that would remain red-hot for a long time. If these were not thoroughly removed at every cleaning, when fresh coal was put on, gas would collect and finally be ignited by the stoker operation.

Gas Filled Cellars

No doubt everybody has read in the papers nearly every winter of somebody driving into a garage, shutting the door and leaving the engine of his auto running, the result being asphyxiation by the exhaust gas. Case (F) is similar but with slightly different trimmings. A young man was running a small picture show with the help only of a girl who sold tickets. When he shut down at midnight he would try to bank the fire in the heating boiler so it would last till the next day noon, using the aforesaid method of entirely banking off the fire by spreading fine coal over the top. This time the fire became inverted and discharged all its CO and CO_2 down into the ash-pit and out into the cellar. When he went into the cellar that noon, he did not come back and when the girl looked down she

saw him laid out on the floor. They got an ambulance and took him to a near-by hospital and succeeded in reviving him by administering oxygen.

Case (G) was a cellar that was a veritable death trap. There had been a coal fired C.I.S. boiler in use. It burst on account of being dry fired. The plumber got the man to install a new boiler and use oil for fuel with auto-burner and low-water cut-out on water column. I went to get the data on the boiler for insurance purposes. On starting into the cellar I immediately detected the odor of burned gases and would not go down until the cellar windows were opened, and the place entirely aired out. We found that a lot of coal soot had slid down the chimney to entirely block off the stack connection of the boiler at the bottom so that all the products of combustion were being discharged into the cellar instead of up the chimney. All chimneys should be built with an ash clean-out door at the bottom.

Case (H) was another cellar, where I smelled an undue quantity of artificial gas. I found the gas pilot on a water heater had gone out and the cellar windows were shut so tight as to prohibit ventilation. Under ordinary circumstances a pilot light uses so little gas that if the room is properly ventilated no harm results. It is well to see that a boiler room is sufficiently ventilated.

With the use of gas or oil for fuel there is always a danger of furnace explosions, even though the furnace be equipped with all the automatic gadgets that are supposed to make oil-burning safe.

The office boy was sweeping up the boiler room when his broom came in contact with the stop-cock to the oil supply to the boiler, turning the oil partly off and the fire went out but still there was a fine spray of oil playing against the heated lining of the firebox. The boy ran up stairs and told them the fire was out and they told him to go pull off the knife switch that controlled the motor pumping the oil. When he did so the spark at the switch ignited the gas that had already accumulated, there was a flash out from the boiler that blew the door and stack connections off the boiler, blew the doors of room open, blew the boy back against the wall and scorched the boy's whiskers and eyebrows, leaving him considerably scared but not seriously hurt. Several other cases similar to above occurred when the owners of oil-burning boilers, finding the fire out, struck matches to look into the furnace.

In the first mentioned case above the outfit did not have the usual safety devices installed for automatic operation. Even with a fully equipped outfit for burning oil the following things may occur to cause trouble: Shots of water coming over with the oil. Pockets of air or gas in the piping. The oil being too cold to gasify. The use of too heavy a grade of oil that is not suitable to the burner used. Stopping up of burners by graphitic carbon residue. Trying to use too low a grade of oil. These are happenings that are liable to put out the flame and if the ignition system does not immediately relight the fire after a minute or so an explosion will happen. We recall a recent accident where the ignition transformer partially burned out making only a weak spark and after about the third try the protecto-relay succeeded in relighting the fire but by that time there was oil all over the floor in the cellar which set fire to the building.

While there are many ingenious and successful types of safety devices in use for oil-burning we would not advise anybody to trust them too far as in our experience we find they will eventually get out of fix and it is well to test them frequently to see if they function. The way to test them is to produce the condition under which they ought to operate and see if they will respond.

Blending Coal

COALS HERETOFORE believed unsuitable for coking may be made useful for carbonizing purposes, by blending with coal of different characteristics, according to an announcement made by the U. S. Bureau of Mines, Department of the Interior. Although the Millers Creek coal comes within the range of rank of coking coals, is low in ash and moderately low in sulphur and gives good yields of by-products, it is not used for by-product coking mainly because it is somewhat deficient in coking power. The problem was to find the extent to which the coking power of this coal can be improved by blending with well-known by-product coals. One of the main objectives of the survey of the gas-, coke-, and by-product-making properties of American coals in which the Bureau of Mines is engaged is to find methods for utilizing such coals against the time when the supply of coals with better coking properties will be exhausted.

DIESEL LUBRICATION

(Continued from page 407)

essential to use filtering media of suitable quality and change when required, or, in the case of centrifuges, to operate them under proper conditions as to rates of flow, speeds, and temperatures. Inadequate removal of finely divided solid material frequently results from a failure to secure adequate equipment, or to use properly.

Filtering, or centrifuging, is not complete reclamation. This important point may escape the attention of the plant operator, who therefore feels that if solids are removed so that the oil looks fairly clean it is therefore entirely satisfactory for further use. This is far from the truth. Oxidation and deterioration of lubricating oil results eventually in the formation of sludge, which being solid, is capable of being removed by a good filter or centrifuge.

Oils may, however, oxidize and deteriorate to a considerable extent without forming insoluble sludge. The oxidation products remain in solution and cannot be removed by filtering or centrifuging. They are visible only as a darkening of the oil, which may, however, be entirely clear and free from suspended material. These soluble oxidation products are objectionable in that they rapidly form insoluble sludge on further oxidation. Thus, this partially oxidized oil may rapidly form some sludge around the rings at the higher temperatures there prevailing, and thus may necessitate shorter overhaul periods than would be the case if a less highly oxidized oil had been used.

(To be continued.)

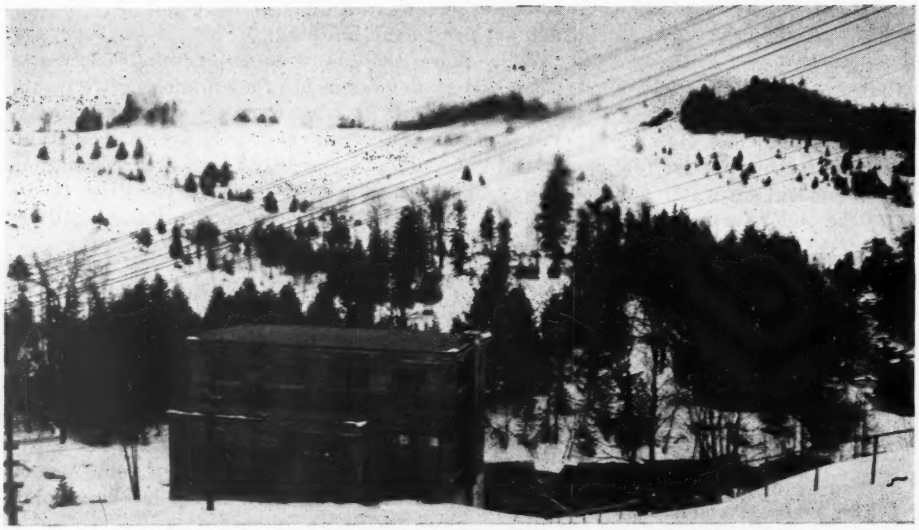


Fig. 1. A winter view of the new power plant of the Newport Electric Corp. on the Clyde River in Vermont

Newport Electric Corporation Adds Hydro Capacity

By L. G. ROPES
Designing Engineer
CHAS. T. MAIN, INC., BOSTON

THE NEWPORT ELECTRIC CORPORATION of Newport, Vermont, has recently completed a re-development of their Newport hydro-electric plant, located on the Clyde River, about two miles from Newport.

Located in northern Vermont, only a few miles from the Canadian border, where there are many opportunities for small hydro-power developments, the entire load of the company is carried by their two hydro-electric plants; there is no steam plant. The company has a connection at Derby Line with the Southern Canada Power Company and also is tied in with a municipal plant at Barton, Vermont, but can not depend on these ties for power.

Of these two plants the one at Newport is the principal one. Its capacity before the re-development was about 1300 kw., and this has now been increased to about 2500 kw. The other plant is at West Charleston, about eight miles upstream from the Newport plant and has a capacity of only about 500 kw.

The company controls four ponds located above these plants. Due to the storage capacity of these ponds, there is ample flow available throughout the year for the power requirements of the system.

The development of water power at the site of the Newport plant has been gradual, and extended over a long period of years. Originally there was a pulp mill and dam located about 1000 ft. above the site of the present plant.

The first unit of the hydro-electric plant was a 250 Kv-a., 2 phase, 60 cycle, 2300 v., 240 r.p.m., Western Electric generator, direct connected to a Holyoke horizontal, double runner wheel. This operated under about 30 ft. head developed by a dam located immediately above the power house, with a short penstock connection.

Next, in the course of the development was the construction of a 5 ft. diameter steel penstock about 1300 ft. long, from the pulp mill dam to the power house, connecting with two new units in the power house, developing a head of about 110 ft. These units have horizontal S. Morgan Smith wheels in cylindrical plate steel casings with quarter-turn discharge. One wheel is direct connected to a 1000 kv-a., 3 phase, 60 cycle, 2300 v., 600 r.p.m., General Electric generator. The second wheel is direct connected to a 600 kv-a., 2 phase, 60 cycle, 2300 v., 600 r.p.m., Fort Wayne generator.

Another masonry-concrete dam was built about 400 ft. above the pulp mill dam, creating a pond which has an area of 210 acres and can be drawn about 10 ft. Water was let down through a sluice gate as required for the water wheels.

The next and 4th step in the development, made in

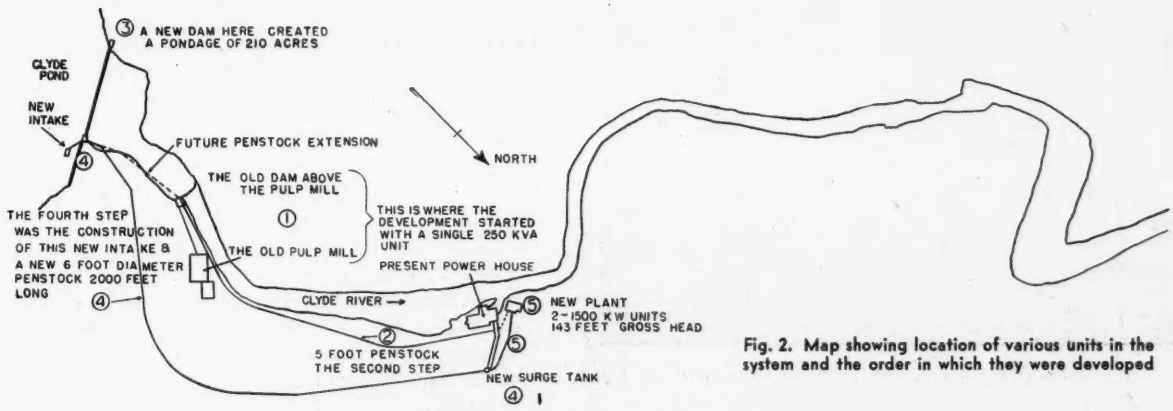

③ A NEW DAM HERE CREATED A PONDAGE OF 210 ACRES
CLYDE POND
NEW INTAKE
FUTURE PENSTOCK EXTENSION
NORTH
THE OLD DAM ABOVE THE PULP MILL
①
THIS IS WHERE THE DEVELOPMENT STARTED WITH A SINGLE 250 KVA UNIT
THE FOURTH STEP WAS THE CONSTRUCTION OF THIS NEW INTAKE & A NEW 6 FOOT DIAMETER PENSTOCK 2000 FEET LONG
THE OLD PULP MILL
PRESENT POWER HOUSE
CLYDE RIVER
⑤ NEW PLANT 2-1500 K.W. UNITS 143 FEET GROSS HEAD
② 5 FOOT PENSTOCK THE SECOND STEP
⑤
NEW SURGE TANK
④ 1

Fig. 2. Map showing location of various units in the system and the order in which they were developed

1931, consisted of the construction of a new intake at the storage dam, and a new 6-ft. diameter penstock about 2000 ft. long, from this dam to a new surge tank about 200 ft. from the power house. Two 54-inch penstocks were built between the surge tank and the power house, and connected to the wheels originally fed by the 5-ft. penstock which was cut off at the power house and abandoned.

This step developed a gross head of about 142 ft. on these wheels. The combined discharge capacity of these two wheels was about 170 cu. ft. per sec.

Re-development

The latest step in the development of power at this site was completed in September, 1936. It consists of the installation of a 1500 kw. unit in a new power house located a short distance below the old power house. Space is provided in the power house for a second unit of the same capacity, to be installed when the load requires it.

A 6 ft. diameter welded plate steel penstock about 260 ft. long was built from the new wheel to the surge tank, with a motor operated butterfly valve, 5 ft. in diameter, in the power house.

The height of the 12 ft. diameter surge tank was increased about 18 ft. to a total height of 30 ft., to provide for the possible increased surge due to the new unit. In addition, a diaphragm was constructed in the bottom of the surge tank, thereby changing it from the simple to the restricted orifice type of tank.

When the second unit is installed, it is planned to make use of the old 5-ft. diameter steel pipe which now extends to the dam at the pulp mill. This will be extended at the upper end to tie in with the 6-ft. pipe near the dam, and at the lower end to tie in with the new unit. It will also be tied in to the surge tank through the old 54-in. penstock now serving the old Fort Wayne unit, thus providing for surge, and equalizing the heads on the units. It may also be reconnected to one of the old units, which could then be used in an emergency.

The connection of the new penstock to the surge tank involved considerable study so that the old units could be kept in operation at all times except during one week end when the connection was to be made. The week end load, which is light, could then be carried by the 500 kw. unit at West Charleston.

As the connection had to be made at the point where one of the old 54-in. penstocks was connected, it involved cutting the 54-in. penstock from the surge tank and connecting this penstock to the new penstock.

The 72-in. penstock was first built around the 90 degree elbow of the 54-in. penstock, where it connected to the surge tank. All joints were welded on the out-

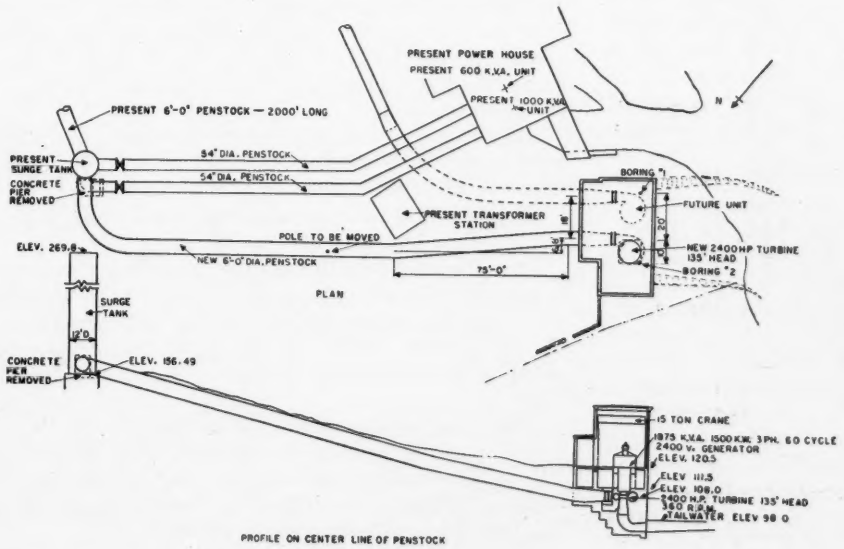


Fig. 3. General layout of the new power house and the new penstock arrangement. The height of the surge tank was increased 18 ft., making a total of 30 ft. This drawing also shows how the new 6 ft. penstock was connected to the surge tank around the 90 deg. elbow of the 54 inch penstock

Fig. 4. The new 1875 kv-a. generator and exciter

side, including the connection to the surge tank, while the plant was in operation. The final connection was made by draining the pipe line, cutting out the 54-in. pipe from inside the new one, and welding all joints on the inside. This was all done in a 36-hr. period from Saturday midnight to Monday at 6 a. m.

The new unit consists of a 2400 hp., 360 r.p.m., 135 ft. head, vertical, Allis-Chalmers turbine of the reaction type, direct connected to a 1500 kw. (1875 kv-a.), 60 cycle, 3 phase, 2400 v., General Electric generator, with direct connected exciter.

The two units in the old power house will be operated until the second new unit is installed. All units are now operated from a switchboard in the old power house. The switchboard will be moved to the new power house when the second unit is installed.

The power house has a concrete substructure with concrete elbow type draft tube, plate steel turbine scroll, brick superstructure with steel frame, concrete roof slab. The two-story type station was used in preference to the mounting of the generator on a raised barrel pier because of the better ventilation possible and because the road grade to the power house door was much better with the door at the second floor or generator floor level. This also permitted liberal space on the turbine floor for governor oil pressure pump, oil heater, butterfly valve control, toilet, etc.

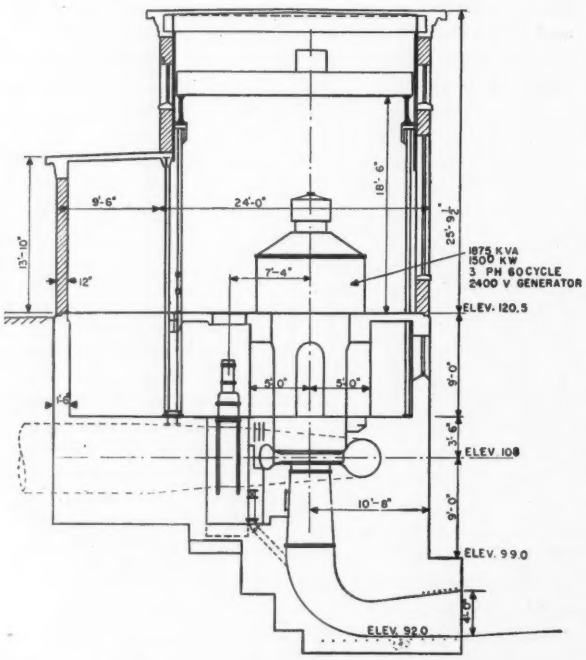


Fig. 5. Cross section through new power plant

List of Principal Equipment in the Newport Electric Corporation Plant

Turbine Equipment—Allis-Chalmers Manufacturing Company:

One 2400 hp., 360 r.p.m., 135 ft. head, turbine.

One Woodward oil pressure governor, 9000 ft. lbs. capacity.

One 5-ft. diameter butterfly valve, motor operated, with 6 in. by-pass valve.

Generator Equipment—General Electric Company:

One 1875 kv-a. (1500 kw.), 360 r.p.m., 2400 v., 3 phase, 60 cycle generator.

One 20 kw., 360 r.p.m., 125 volt, direct connected exciter.

Switchgear furnished by General Electric Company and erected by the Newport Electric Corporation.

Wiring—J. Livingston & Company.

Penstock and Extension to Surge Tank—Walsh-Holyoke Steam Boiler Works.

Power House Crane—Shaw-Box Crane and Hoist Company.

Boiler—H. B. Smith Company.

Oil Burner—Petro.

The General Contractor on construction was Vappi & Macdonald Co., Inc., of Cambridge, Mass.

The plant was designed by Chas. T. Main, Inc., Engineers, of Boston, Mass.

The Newport Electric Corporation is under the management of the Citizens Utilities Company, Minneapolis, Minnesota.

The generator floor slab around the second unit will not be built until that unit is installed. The switchboard will be located at the generator floor level in an extension to the power house, but will not be installed until the second unit is put in, the first unit now being operated from the switchboard in the old power house. The generator is protected by temperature detectors in the generator coils.

Since existing transformers were too small they were replaced by three rebuilt 500 kv-a. transformers from the Richford substation.

For handling the equipment the power house is provided with a 15-ton hand operated crane.

An oil burner installation with steam boiler and unit heaters is provided for heating the power house at times when insufficient heat is furnished by the operation of the generators. There are two unit heaters, one located on the turbine floor and one in the main generator room.

The principal equipment and contractors for the redevelopment is listed in the accompanying tabulation. The re-development was designed and constructed by Charles T. Main, Inc., of Boston, Massachusetts, under the immediate direction of W. F. Uhl.

Freezing a Dam

Refrigeration Plus Ingenuity Provides the Means of Holding Back an Earth Slide at Grand Coulee Dam

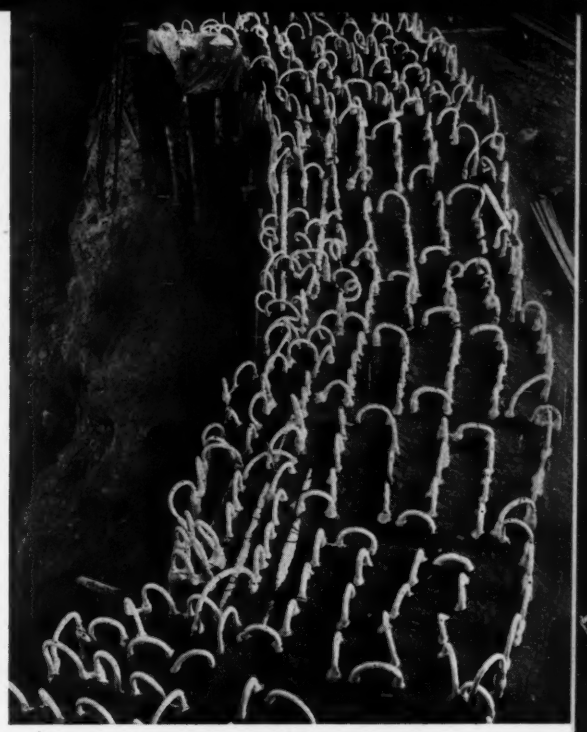


Fig. 1. A close-up of the frozen earth dam

GRAND COULEE DAM on the Columbia River is the largest structure man has yet attempted. It will be about 550 ft. above elevation, 4200 ft. long and contain several times as much concrete as Boulder Dam. During construction a number of slides developed, one particularly bad one appearing near the east forebay in a gulch which runs parallel with the river and crosses the axis of the dam at nearly right angles. The earth, or silt, which has a tendency to flow, is extremely fine and contains from 20 to 25 per cent colloidal matter. When wet and disturbed, the material is about the consistency of axle grease. During a dormant period of slide, a concrete dam was constructed and was topped by a rock-filled crib. Before it was complete, however, the slide started again, overtopped the dam and made some other course of action necessary if complete excavation of the job was to be avoided.

After some discussion a frozen arch dam was decided upon. Although this method of construction had been used to a limited extent in Europe for sinking shafts, little data were available. Two ammonia compressors with a combined capacity of 80 t. were located, however, and using this capacity for one known factor and the length of time available for freezing for another, the plant was designed and the arch laid out on a 105 ft. radius, on top of the rock filled crib, where the canyon was about 100 ft. wide.

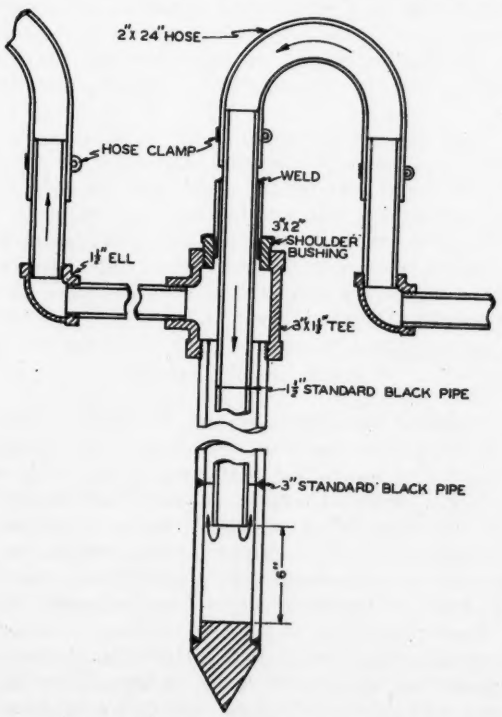


Fig. 2. Details of the construction of the freezing points. The average length of these points was about 42 ft.

Three weeks were allowed for freezing and the pipes were placed 30 in. apart, this distance being arrived at by assuming that 10 deg. brine would freeze 6 in. of material in 2 days, 12 in. in 8 days and 15 in. in 20 days. These figures were based on the freezing rate of ice and were considered conservative because the specific heat of the material had an average water content of 32 per cent. Actually the material behaved somewhat differently than anticipated because of the high heat conductivity.

Blunt End Best

Design of the freezing points is shown by Fig. 2. They consisted of 3 in. standard blank pipe, with a 1½ in. pipe inside and extending down to within 6 in. of the bottom. As a rule standard pipe caps were used except where conditions required the driving point as illustrated. The blunt end was found to drive straighter with less tendency to be deflected by rock and gravel. The 3 in. pipe was driven in stock length of 21 ft. and most points required two lengths.

Sixteen points were connected, in series, in a group between headers by means of valves on both headers and 2 in. flexible hose between points. These points were spaced 30 in. centers both ways and the arch formed by 8 parallel rows as shown in Fig. 1, plus about 25 extra points on each abutment, making a total of 377.

At the beginning the temperature rise of the brine was maintained at 8 deg. F., giving a total refrigeration effect of 70 t. and both machines were required operating at a suction pressure of 20 lb. per sq. in. A

circulation of 170 g.p.m. gave a velocity of about 1 ft. per sec. through the freezing points, the flow being equalized manually by means of valves. After about 6 wk. either machine could hold the temperature easily.

At the time driving was started the center of the arch was moving downstream at the rate of about 2 ft. per hr., but had stopped by the time freezing began. Some movement developed during freezing, however, and it is thought that this resulted from expansion. Compression tests made on 6 by 12 in. cylinders, with moisture contents ranging from 32 to 50 per cent ran from 400 lb. per sq. in. at 15 per cent shortening of the cylinder to over 600 lb. per sq. in. with 5 per cent shortening. Temperature gradients upstream ran from an average of 15 deg. F. at the face of the dam to 40 deg., 2.5 ft. upstream and a ground temperature of 55 deg. at an average of about 9 ft. upstream.

The compressors consisted of a 9½ by 9½ in. vertical Baker compressor, driven by a 60 hp. General Electric motor and a 9 by 9 Frick vertical compressor driven by a 50 hp. Allis-Chalmers motor. Two 20 in. by 20 ft. shell and tube type condensers were used. The brine coolers, also of the shell and tube type, were 22 in. by 22 ft., with an effective cooling area of 486 sq. ft. The compressors, condensers and brine coolers were connected in parallel so that any piece of equipment could be removed from service without interfering with the operation of the others.

Brine was pumped by a 7½ hp. centrifugal pump through the coolers down to the freezing points and back to the open surge tank. Brine flowed to 3-in. brine line at the side of the gulch and divided through two 3-in. supply headers. Return headers were connected to the surge tank by means of a 3-in. riser.

Annual Convention of N.D.H.A.

Meeting in Detroit May 25 to 28 was noteworthy for the amount of information presented of direct value to engineers in charge of operation

DURING the past year the committees, that reported their findings to the National District Heating Association at the meeting held in Detroit May 25 to 28, working under the direction of the president of the Association, M. D. Engles, have compiled a great amount of valuable information which will be extremely useful to the industry. Of the eight committees to report, seven dealt with technical engineering construction and operating problems and only one with commercial relations.

T. E. Purcell

Interspersed in the program of the convention were a number of social events, inspection trips and the annual golf tournament in addition to a full program arranged for the ladies in attendance. Officers elected for the coming year are: T. E. Purcell, The Allegheny County Steam Heating Co., President; J. R. McCausland, Philadelphia Electric Co., 1st Vice Pres.; G. D. Winans, The Detroit Edison Co., 2nd Vice Pres.; Edward Lenz, New York Steam Corp., 3rd Vice Pres.; Executive Committee: M. D. Engle, Boston Edison Co., F. L. Witsell, Toledo Edison Co., and J. M. Arthur, Kansas City Power and Light Co.; Wm. H. Sanford, Secretary-Treasurer, 1317 Spruce St., Philadelphia, Pa.

Hypothetical Problem Solved

Reporting for the Distribution Committee, William A. Herr, chairman, stated that this report dealt with the effect of design on the cost of underground steam lines and manholes. In order to get a comparison of the different designs without complicating the problem unduly, a problem specification was prepared and also a plan made of a hypothetical city block showing various underground obstructions such as affect both the design and construction. These obstructions were so placed as to require both deep and shallow construction for the line and manholes, thus bringing into the study such problems as tunneling, shallow and deep excavation, excavation below an adjacent building foundation, natural and mechanical drainage of manholes, provision for future service extensions, provision for pipe and duct expansion, provision for drainage of condensate from the line, and other practical considerations.

When the specifications of the problem were outlined, three tables of labor and material were prepared for each design, one for the piping and cut, one for the shallow manhole, and one for the deep manhole.

The primary purpose of these tables was to make it possible for one to apply his local unit costs to the material and labor quantities and thereby obtain a comparison based on local costs.

Summer Load Opportunity

Prefacing the report of the Research Committee, G. K. Saurwein, chairman, stated that the committee had included again this year some worth while work relating to steam jet cooling, believing that this subject is of vital importance to district steam companies. It offers summer load building opportunities as does perhaps no other steam equipment available at this time, and therefore should be studied continuously.

Another subject which the committee considered important is the study and distribution losses, compiled in this year's report by Messrs. Griswold and Kelsey. The data are meager, only five companies participating, but the amount of the losses is sufficient proof of the importance of the subject. This year's

report is merely a beginning. The Committee recommended that the study be continued to determine the relative importance of metering losses, insulation losses, losses in the consumer's premises, etc., with the end in view of finding ways of reducing them.

Included in the report was a paper on a new instrument set-up, named by its developers the "Enthalmometer," for use in the production of "standard steam" with a small amount of superheat for testing purposes.

Two other uses for steam in the summer time have occupied the Committee's attention; viz., low pressure steam for absorption refrigeration and the use of low pressure steam in connection with lithium chloride for humidifying and dehumidifying.

Meter Specifications

The report of the Meters and Accessories Committee, W. W. Stevenson, chairman, consisted of three sections, having no direct connection with one another. Section 1 was a Description of a Demand Attachment for Shunt Flow Meters. Section 2, A Report on the New Isometer Flowmeter, and Section 3, Tentative N.D.H.A. Specifications for Improvement in Steam Metering.

Under the discussion of specification the Committee reported that meters already on the market have established standards of accuracy throughout limited ranges, which for the present may be considered as typifying the meaning of the word "acceptable," as used to define accuracy in these specifications. No such practical definition can be placed on the term "permissible accuracy," as used in connection with the low load and overload ranges. It is sufficient to observe that in too many meters now on the market the accuracy within these ranges is not permissible. Large improvement in the range of reasonably accurate metering, along with other demanded qualifications, must be made before it will be worth our while to enter into any extended study of accuracy. If and when such improvement is made in actual meters it will then become the duty of this Committee to define the limits of metering accuracy with a degree of thoroughness that would make these results of value to our various Public Service Commissions.

Interest and development of district heating in Europe continues to favor the use of hot water, said A. W. Wieters, chairman of the Hot Water Committee, in presenting his report. On the other hand, there has been no reversal of the trend over here away from district hot water and one case of the abandonment of an old system has been noted.

Two papers were presented in the report this year. The first dealt with the effort now being made to develop a B.t.u. meter. The other paper was the description of a unique hot water heating system, 52 yr. old, which last year was converted to district steam system.

In the summary of the report of the Committee on Operating Statistics, Arthur D. Leach, chairman, stated that factors affecting the steam business during the year 1936 were mixed, with increasing costs and a lower rate of return for steam sold, on the one side and an improvement in the connected load and building occupancy on the other. The very uncertain element of weather seems to have been the controlling influence which resulted in a general increase in the quantity of steam sold last year. In the case of companies who have such tariff provision, fuel and/or labor surcharge clauses will neutralize much of the advance in the cost of either or both of these items. The present unsettled conditions and the improvement in building occupancy are also favorable toward future increases in load.

Although the outlook for continued development of the steam business appears to be uncertain at this time (April, 1937), the situation is probably not as bad as it was in 1932 and 1933. However, no sufficiently definite expressions of opinion are now available to warrant even a guess at what will transpire during the coming year.

Operation Problems

Extremely valuable to the engineers in charge of operation was the report of the Steam Station Engineering Committee of which A. R. Mumford is chairman. In this report were given in detail a number of problems met by various operating companies and the solutions they used. One of outstanding interest was the changing of a district heating plant from hand-fired coal to automatic heavy oil by the Edison Electric Illuminating Co. with entirely satisfactory results.

Another section of the report dealt with short sketches of plant experiences in which attention was given to such subjects as evaporators, air supply to furnaces, air preheaters, ventilation of boiler rooms, stoker siftings, cinder collection, blowing down boilers, distribution of feedwater in the boiler, boiler baffles, oxygen in feedwater, top plants, exhauster fans, boiler carry-over and packing for rods. Experiences with agitators of coal for stoker firing were also related, and a description of apparatus for feeding concentrated acid to boiler feedwater was given. The final section of this report dealt with modern power plant piping.

In the report of the Chemistry Committee, under the chairmanship of Harold Farmer, principal attention was given to a discussion of the limitations of present methods of determining steam purity, a problem which has been complicated by the rapid developments that have taken place in steam generation using boiler pressures up to 1800 lb. with demands for high rate of evaporation, necessitating more thorough treatment of feedwater.

Another section of this report dealt with the pretreatment of coal for the prevention of slag formation on boiler tubes in the conclusion of which it was stated that there is some evidence that intelligent study of all the conditions involved may develop some satisfactory means for improving the slagging qualities of the low grade coals. The opinion was expressed that the use of materials of the calcium chloride type will find application only in the powdered fuel type of furnace because the low melting material dropping from the tubes would be detrimental to the stoker furnace fuel bed.

The Commercial Relations Committee report summarized by Leonard S. Phillips, chairman, stressed the work done by the members of the Committee on the booklet recently published under the title, "Principles of Economical Heating." Other features of the report related methods of handling customer problems, described a new system of heat control and cited publicity methods employed for bringing district heating advantages to the attention of prospective customers, illustrating the type of material to be presented by a symposium of papers.

The Method of shrinking shafts into rotors and flywheels and their removal by heating is well known. Here, however, is a case in which the entirely opposite procedure was employed, the shaft was extracted by cooling instead of heating.

Large Generator Shaft Extracted with Dry Ice

THE VALUE of "dry ice" for dismantling and assembling major shrink-fits has been definitely established at Niagara Falls, Ontario, where a 40-ton steel shaft has been extracted from a 270-ton rotor of a 55,000 kv-a. hydro-electric generator by cooling the shaft with a mixture of dry ice and alcohol.

When it was discovered during February last that the top end of the generator shaft was damaged on No. 10 vertical hydro-electric unit in the Hydro-Electric Power Commission of Ontario's Queenstown generating plant, the problem immediately facing the operating staff was how to extract the shaft with the minimum of expense. Heretofore when defects, such as surface fractures, etc., have developed in large generator shafts it has been the practice to dismantle the rotor windings from the spider and apply heat to expand the spider and thus release the shaft. In this particular case the operating staff believed that by freezing the shaft it could be shrunk sufficiently to extract it and thus avoid the expense of dismantling and reassembling the windings. Because this was a pioneer experiment a small experimental model was first made and taken to the Department of Physics of the University of Toronto to check theoretical calculations. As the model behaved in accordance with expectations a similar set-up was made to extract the large shaft at the generating station at Queenstown on the Niagara River.

Fig. 1. Set-up for removal of the 40 ton shaft with operator at the potentiometer. Shaft, rotor and mixing tank are well insulated with Kapok

Generator of Especially Heavy Construction

This tenth unit at Queenstown generating station has a generator rating of 55,000 kv-a., 80 per cent pf., 25 cycle, 187.5 r.p.m., while the hydraulic turbine is rated at 58,000 hp. at 294 ft. head. A very heavy type of construction is employed on account of the high value of the fly-wheel effect (21,000,000 lb. ft.^{2}). The spider is of the laminated ring design with an inner cast steel spider consisting of a hub and arms but no rim. The laminated rim is built up of 1/16 in. rolled steel plate. The run-away speed for which the machines have been designed and tested in the powerhouse is 185 per cent of normal speed. Total weight of the generator, rotor, the turbine and the unbalance hydraulic thrust is carried on a Kingsbury thrust bearing supported on the top bracket.

The generator shaft by itself is 363 in. long, about 32 in. in diameter at the 60-in. spider section, has an 8-in. bore throughout its length, and weighs 40 tons. The rotor (without the shaft) weighs 270 tons. When it was assembled the rotor, which has a diameter of

32.000 in., was heated to a temperature of about 900 deg. F. and the shaft, which has a diameter of 32.009 in., was inserted, the consequent cooling creating a force between the shaft and hub of about 40,000 tons.

The rotor was placed on the floor of the repair shop at one end of the generating station, the lower end of the shaft projecting down through a hole in the floor. Over both the shaft and the rotor was wrapped Kapok for insulation. Alongside the rotor a tank about 11 ft. in height was set up and also well insulated with Kapok. From the bottom of the tank a 3-inch pipe was connected to a 200 g.p.m. pump and thence to the bottom of the hollow shaft. From the top of the shaft another 3-in. pipe led back to the mixing tank.

Electric space heaters were previously inserted in the rotor and the temperature slowly brought up to

Fig. 2. Looking down on the rotor half an hour after completion of the extraction. The 30 ft. shaft is free and has been dropped down through the spider to the floor below. Note the white frost on the shaft

150 deg. F. About 350 gallons of alcohol were then placed in the tank and circulated at room temperature in order to avoid setting up excessive mechanical stresses in the parts. Next 3 tons of carbo-ice in about 30-lb. chunks were placed at intervals in the tank, resting on grates in the bottom of the tank, the temperature of the freezing mixture dropping to —97 deg. F. Pumping was started at 8.50 a. m., April 1, 1937, the first movement of the shaft was observed at 9.45 a. m., and the shaft was completely free and out of the rotor by 10.50 a. m. The action was assisted by two 75-ton hydraulic jacks and after two lifts of 3 in. each the weight of the shaft alone was sufficient to keep it in motion. It is highly probable that in view of the fact that the method worked so well, that the removal could have been carried out without the aid of the hydraulic jacks.

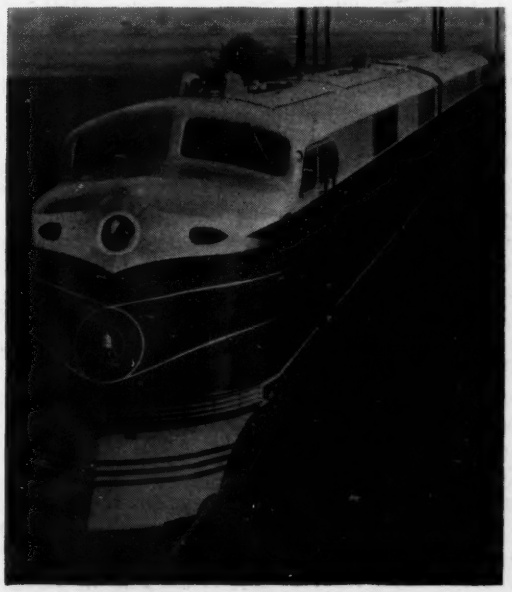
Temperature readings from 32 thermocouples located at various points on the shaft and rotor were taken on a potentiometer during the procedure. The operator, shown in the illustration, is taking potentiometer readings of the rotor in which the space heaters are slowly bringing up the temperature of the spider before the freezing mixture is circulated. The large galvanized pipe leading from the top of the mixing tank is a common furnace pipe to carry off the fumes from the tank.

After the shaft has been repaired it will be replaced by the same procedure.

Coast to Coast Diesel Service

THIS is one of two locomotives scheduled to pull the Capitol Limited of the B. & O. from Washington to Chicago. Thus the last link in Coast-to-Coast Diesel transportation will be completed with a running time of about 54 hr. C. W. Galloway, Operating Vice President, who came to the Electro-Motive Works to receive the locomotive, is the third generation of Galloways intimately connected with the B. & O. railroad, and, the Diesel represents the third type of motive power used by the railroad in its more than a century of existence. His grandfather drove the first horsecar on the B. & O.; his father, identified with the early steam era, knew the feel of the throttle of the famous Atlantic built in 1832; and he himself has played an important role in the new Diesel venture.

Each locomotive consists of two units, each with two 900 hp. Winton engines, each engine driving two 450 hp., 600 v. d.c. motors. Control of all four motors is from a single station in the cab although individual engines may be cut out of service from a local control station at the engine. Either unit of the locomotive may be used separately if desired. Engines are 12 cyl., two cycle, V-type with 8 by 10 in. cylinders and rated at 900 hp. at 750 r.p.m. A cooling unit, hung from the roof hatches, and with three 26 in. propeller fans belted to the main engine, takes air from grilled openings in the sides of the body and discharges through the radiator assemblies. Steam for heating the train is supplied from an oil fired steam boiler.



More important to the railroad field, the first car unit of the locomotive, with two 900 hp. engines, has been designed by the Electro-Motive Corp. as a standard unit for railroad service. It is hoped that its introduction will obviate the need for special designs heretofore considered necessary for each railroad. With the recent additions, the Electro-Motive plant at La Grange, Ill., has a capacity of from 150 to 175 locomotives a year.

Readers' Conference

Oil Burners for Power Plants

THE ARTICLES APPEARING in recent issues of Power Plant Engineering on the above subject seem to be a discussion of the relative efficiencies of oil burners operating with steam atomization, relative to mechanical type atomization.

There are other features, or angles, of consideration involved in this problem, that I think merit consideration and should be considered before deciding as to which type of oil burner to install.

In 1930, we were faced with the problem of making extensive repairs to existing coal handling equipment, together with the installation of some quite elaborate coal handling and storing equipment, or to abandon the coal handling problem altogether and make installation of complete oil burning equipment. We gave ample consideration to the various types of oil burners and all associated equipment and finally decided to install oil burners of the mechanical atomization type. The selection of equipment was all based on one view-point, that being, to make installation of such equipment as to provide continuity of boiler operation. It might be well perhaps to amplify this statement with the fact that the oil burners had no moving parts whatsoever, but that the oil was caused to rotate at the very tip of the burner; and because of its release at the tip of the burner from a high-pressure condition to a low-pressure condition the oil flashed into vapor, or minute particles of oil, so that the burner might be classified as a pressure atomization burner.

Our fuel storage tanks were located under ground. Our oil pumping plant consists of two motor-driven fuel-oil pumps of a combination rotary and piston type and one steam-driven piston type fuel-oil pump; these three units all being of the same capacity. Between the fuel-oil pumps and the oil burners, we made installation of two fuel-oil heaters.

Oil is piped from the fuel-oil tanks to the inlet side of the pumps, thence through the pump and from the delivery side of the pump to the fuel-oil heaters, and from the outlet of these heaters it is piped direct to the front of the boilers with suitable branch line connections to each fuel-oil burner. The end of this line is fitted with an air chamber and the pipe line is continued back to the fuel-oil storage tank. A stop valve is connected into this line, which is beyond the air chamber, and this valve is kept closed.

Between the delivery side of the fuel-oil pumps and the inlet to the fuel-oil heaters, we have fitted a tee. The branch outlet of this tee connects with a balanced diaphragm operating valve. A spring under the diaphragm holds the balanced valve closed; this spring is adjustable. The discharge pressure from the fuel-oil pump is piped so as to communicate with the opposite side of the diaphragm, so that when the pressure being supplied to the oil burners reaches the desired amount, this pressure forces the balanced valve open, and the oil thus released is conveyed by means of pipe line back to the storage tank; thus the flow of oil to the fuel-oil burners is maintained at constant pressure and any excess volume being delivered by the fuel-oil pump is automatically returned to the storage tank. The temperature of the oil in our storage tanks is maintained constant at about 100 to 110 deg. F., by means of steam supplied to these tank-heating coils and controlled by a temperature regulating valve; the element, however, of this temperature regulator is connected into the oil supply pipe near the pumps. The steam heating coil for these tanks is a coil of pipe coiled around the oil supply tank to the pump and so installed that the incoming steam goes direct to the bottom of the coil first, then circulates around the suction line to the top of the tank. The outlet from this coil is then carried to the bottom of the tank and a radiation coil is fitted along the bottom of the tank with its outlet carried out of the tank and connected to the drain. We have found from actual practice, that this coil actually condenses all steam being allowed into this coil by the action of the temperature regulating valve and that there is never any steam blowing from the outlet.

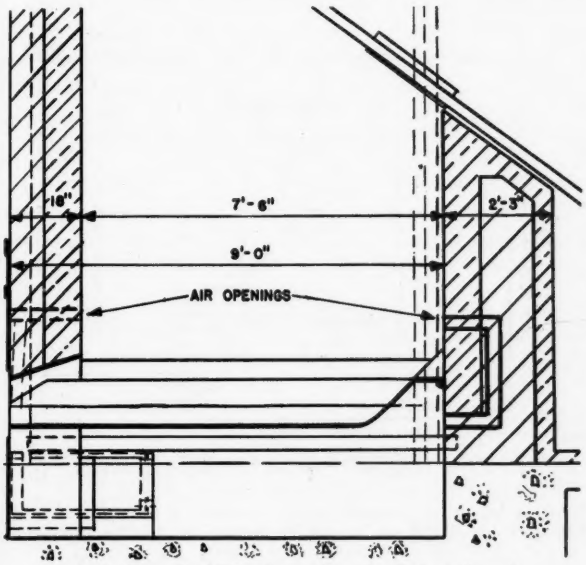
It is not necessary, therefore, that we have a trap on the outlet from these heating coils and it is surprising to see the small amount of steam that these coils use in maintaining temperature of 100 deg. F. It is well to note that in this type of set-up, we are not returning to our storage tank the high temperature oil being supplied to the burners, but we are returning to the tank the same temperature oil that has been taken from the tank. There is, therefore, no danger of our return flow oil increasing the temperature of the oil in the storage tank. Our usual method of operating this plant is to use the motor-driven oil pumps, alternating their service each week, so that both pumps are kept in good operating condition. If, for any reason, the supply of electric current should fail (and by the way, these failures usually occur at a time when they are most unfortunate), we have provided ourselves with the protection of the steam-driven piston type fuel-oil pump, and we are therefore, able to continue our boilers in service at any time the electric current fails, by putting into service the steam-driven pump. This installation has given us very satisfactory service since December, 1930, and we are in every particular well satisfied with its operating characteristics.

Hartford, Conn. HARRY W. BENTON.

Over-fire Air Reduces Smoke

STOKER fired furnaces designed for coals having certain specified characteristics are often called upon to burn coals having entirely different properties. At normal fuel burning rates this is usually done without any appreciable decrease in combustion efficiency. At extremely high ratings substitute coals of a lower grade often smoke excessively and cause other serious operating troubles.

This condition was recently experienced in an industrial boiler plant having stokers and furnaces built to handle 200 per cent of boiler rating with a high grade Eastern coal. Changes in fuel prices and rail rates, however, dictated the selection of a Middlewestern bituminous coal as being a desirable means of reducing the overall cost of steam. While this fuel



Introduction of additional over-fire air eliminated smoke

proved reasonably satisfactory at low ratings, considerable smoke was emitted when the stoker was forced up to and over its guaranteed capacity. As a check of furnace volume proved its adequacy, every indication pointed to insufficient air and turbulence over the fire for the high volatile content of the new fuel. By admitting more over-fire air through the bridge wall, as shown in the sketch, all smoke was eliminated and a marked improvement in combustion efficiency noted.

Roanoke, Va. S. H. Coleman.

Check Valve Out of Perpendicular

In installing a feedwater pipe on a boiler a careless engineer put in a check valve out of perpendicular. In other words, the injector end of the pipe was higher than the end which entered the boiler. The difference was small in inches and appeared insignificant to the eye, but was sufficient to cause the valve to seat poorly, or at times to "hang," causing a loss of water sufficient to lower the efficiency of the boiler greatly. The frequent use of steam to replenish the fast diminishing supply of water made it difficult for the fireman to keep the required steam pressure. Also, the constant injection of cold water tended to chill the boiler.

At first the disappearance of the water was a mystery to the fireman, since he thought he could take care of leaks in the check valve by closing the injector waste (or overflow) valve; but he soon learned that an injector is hollow, and that any attempts to stop the loss of water leaking by the check valve by closing the injector valves were futile, since the water flowed easily past the injector-valve stems and passed through the suction pipe back into the pool.

The loss of water was finally stopped, however, by putting a cutoff valve in the water line between the injector and check valve. This was an emergency measure, considered easier than putting the check valve in a perpendicular position; but this method has its disadvantages, in that the valve increases the resistance to water flow, has to be opened when it is desired to inject water, and has to be closed between injections.

At the same plant, the fireman left a jet steam-line valve open one evening after the steam pressure had become too low to operate the jet. He was surprised the following morning when the jet refused to operate upon charging the line with the usual steam pressure. The explanation is that the jet was located 600 ft. from the boiler, and there was a long sag in the steam line. The sag was full of water which had condensed from steam during the night. The volume of water and the amount of resistance was sufficient to cause the live steam to condense before it could possibly reach the jet. The trouble was quickly cleared up by draining the water from the steam line so that the steam could reach the jet.

McCool, Miss. Bunyan Kennedy.

Can Wastefulness Be Economical?

It often has been said that where fuel is cheap it does not make much difference whether or not the steam boiler, steam engine, Diesel engine, or electric motor is efficient—that the fuel doesn't cost much anyway and therefore the waste is insignificant.

That, however, is a fallacy that is worthy of careful thought.

For example, in the coal fields. where coal costs very little, it is evident that it is more economical to operate a single boiler whose efficiency is 80 per cent than to operate two boilers having the same initial cost at 40 per cent efficiency each. It would require two boilers and twice as much coal to do the work of a single boiler kept clean having an efficiency of 80 per cent. Not only would two boilers have to be purchased in the first place but they would require twice as much floor space, a building twice as large, additional piping, the cost of labor for shoveling the coal would be greater, taxes would be greater, depreciation greater, etc. The fact that coal costs practically nothing in the coal district is therefore no good reason why one can afford to be wasteful.

In the same way an engine or electric generator of high efficiency will do more work than an engine or generator of low efficiency. It generally pays to keep efficiency high.

On the other hand there is such a thing as "too much efficiency." A machine that is highly efficient invariably costs more than one that is inefficient. Thus if, for $1,000,000, one could develop an engine that would produce one horsepower of energy at no cost whatever for fuel, it would still be much better to buy a cheap wasteful engine because the interest alone on $1,000,000 at 5 per cent is $50,000 per year.

There is plenty of free harnessable energy all around us that we can have for nothing if we want it, that is, if we can obtain the necessary machines for doing the harnessing for nothing. The wind, for instance, contains considerable power and "all that is

necessary'' to harness it is to build a windmill, put in generators, storage batteries, and so forth. The same is true of the tides and of sun power. However, the first cost of the equipment for doing this harnessing is so high that we usually find it more economical to purchase fuel and use machinery that has a lower first cost per horsepower developed.

Newark, N. J. W. F. SCHAPHORST.

Less Worry from the Fly-Ball Governor

THERE WAS a day when an accident to the fly-ball governor was serious indeed, because an accident of any kind to the governor, or to the belt which ran the governor, naturally meant a runaway engine and highly serious consequences. It is well that modern engine design usually provides some type of device for stopping the engine automatically in case anything happens to the governor.

Simply because an engine is provided with such a device, however, there is no virtue in neglecting the governor or the governor belt. In fact, it is a splendid habit to continue periodical inspection of the belt. When one happens to light on the operation of an old engine which does not incorporate a safety stop device in addition to the governor, he will find it was well indeed that he kept himself in the habit, at least in a measure.

Really, it is a very good idea, every time the engine is down, to examine the governor belt on an old engine that incorporates no safety device aside from the governor, and again preferably just before starting it. Where there is a safety, of course, the habit need not be so rigorously maintained, but it should be kept in mind.

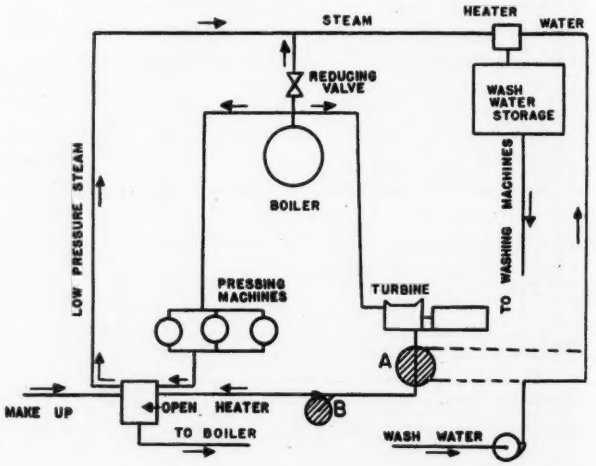
Possibly the day will come when there will be no engines in operation which do not have a safety stop device efficient enough that one can dismiss the thought from mind permanently. If so, it will be well indeed.

Peoria, Ill. JOHN E. HYLER.

Operation at Partial Vacuum

IN THE USUAL piping arrangement of the steam and water cycle found in laundries, which is also representative of other industries having similar cycles, high pressure steam is used for power generation and also for pressing and other machines. The power machine exhausts to the open heater which is used for heating the feed for the boiler. The condensate from the high pressure machines as well as any low pressure condensate and low pressure steam is also returned to the open heater. The water for washing is heated in a separate heater which discharges to a storage tank and the steam for this heating is the surplus from the open heater and the remainder, if needed, is taken from the boiler through a reducing valve.

The layout shown here is modified so as to make the operation condensing. The wash water is heated in two stages, the first being a closed heater, which from the standpoint of the turbine is a surface condenser. For the laundry plant investigated, there was sufficient wash water requirements to permit the operation of the turbine at 3 lb. absolute pressure, which would result in a reduction of steam for power of about 40 per cent. Since the steam for power was about 50 per cent of the total, the fuel reduction possible with condensing operation was indicated to be roughly 20 per cent.



Proposed layout for a laundry plant to operate condensing. Without figures A and B and the broken line piping the diagram represents the usual layout of a laundry plant

With the trend in the laundry industry toward more labor saving machinery, there will be an increase in the power load with the result that more exhaust steam might be available than can be absorbed in heating the wash water. Condensing operation as described will correct such condition.

Back pressure of turbine, lb. per sq. in. abs.	20	6	4	2
Temp. to which water can be heated, initial temp. 60 deg.	...	150	125	100
Lb. water required to obtain back pressure of line 1; lb. cold water per lb. steam	...	10	13	20
B.t.u. available for power with 150 lb. abs. prs. sat. steam	120	180	200	220
Per cent reduction in steam consumption	...	33	40	45

The third line of the table gives the amount of circulating water required for various absolute pressures for condensing operation. Any establishment where the water to be heated is comparable to these figures can with advantage operate condensing, using the water to be heated as circulating water, provided such cycle is favorable to the heat balance of the plant. That is to say, if there is an excess of low pressure steam, the condensing cycle will tend towards a heat balance, while there will be no advantage if all of the exhaust steam can be absorbed.

Chicago, Ill. N. T. PEF.

Preparing Waste for Pad Oil Bearings

MANY SLOW moving lineshafts are lubricated by pads of waste saturated with oil. Waste for this purpose should be thoroughly dry and then soaked for 48 hr. in some good grade oil. In cold weather the oil should be warmed, so as to ensure complete saturation. The waste should then be placed on a rack and allowed to drain so that any excess oil is removed. It is important that draining is complete, as an excess of oil increases the pad weight.

The waste can then be placed in the bearing, the addition of fresh oil will be necessary at intervals as the waste begins to dry. The surface of the waste is also liable to glaze in time. It should be roughened to prevent this as often as necessary.

Sussex, England. W. E. WARNER.

The Mystery of the Unbalanced Fan

A FEW DAYS AGO a short news item, tucked away in an obscure corner of a daily paper, was called to my attention. It, apparently, was only a minor bit of news; a forced draft fan had exploded, from some undetermined cause, and killed two workmen.

Eighteen years ago I had a plant of five, 1000-hp. boilers served by three forced draft fans and two induced draft fans handling approximately 100,000 cu. ft. of air per min. with three boilers in operation.

One day the boss fireman called my attention to No. 1 fan, turbine driven and operating at 1500 r.p.m. which had suddenly developed a case of the jitters or vibration.

One man of the crew was an expert at balancing, so I put him on the job and he reported that he had changed the balancing weight just 180 deg. and the machine ran perfectly "OK."

After looking it over I agreed that he had done a first class job and immediately forgot it.

Not so my boss fireman. He went to the plant that night to satisfy himself that the fan was operating as it should and came away satisfied.

But the next morning, upon examination of the unit, he called me again and there was, beyond question, vibration.

The mechanic again chalked the rim and reported that it was necessary to replace the weight in exactly its original position. Again the unit operated without any sign of distress.

That night I went to the plant myself and looked the unit over thoroughly but its performance was beyond reproach.

The next morning the boss fireman was waiting for me in my office with a very worried look. He admitted that he was decidedly upset about that forced draft fan as it was running out of balance again.

Once more our mechanic tried it out and found that he must place the weight directly opposite to balance it properly.

Then I got the fan builders on the long distance and asked for their best man. It doesn't make me feel ashamed to admit that I was worried; in fact, *very worried.*

The fan expert arrived and I told him the facts of the case. We removed the housing of the fan and no imagination or magnifying glass was necessary to see a very ugly crack in the spider.

Very nonchalantly the factory man remarked, "You stopped her about the right time, mister. A short time ago, a mate to this one, same speed, same diameter and about the same age went to pieces and killed two men."

We had the other two inspected and replaced one spider but when I read that little obscure item the other day it made me wonder if we really do inspect machinery of this kind at often enough intervals!

New York City. C. W. PETERS.

Fuel Oil Temperature

I WOULD like to know what is the highest temperature it is safe to carry on tank of Bunker C oil 12-14 gravity without losing the suction on the oil pump and any danger of fire or otherwise in the tank.

W. D.

Bunker C oil varies a good deal in composition, depending upon where it came from. It runs, as you state, from 12 to 14 Baume gravity and the lowest flash point allowable is 150 deg. F., closed cup test. As a matter of fact, the flash point varies all the way from 124 deg. for a 12 gravity Panuco oil to 280 deg. for a 13 gravity California oil, and from 140 deg. for a 14 gravity Panuco oil to 225 deg. for a 14 gravity California oil. You will see, therefore, that it is necessary to know the flash point of the oil which you are handling before the safe limit for heating can be stated.

The fire regulations of the National Fire Protection Association state that the highest temperature of oil must be 40 deg. below the closed cup flash test and New York Storage Regulations state that the heating shall be to not over 140 deg. F.

The danger in overheating is, of course, that the oil may become ignitable and also too high a temperature will result in sputtering and uneven operation of the flame at the burner. One authority gives the maximum temperature for a 14 Baume oil as 220 deg. and for a 12 Baume oil as 260 deg. A method frequently used is to heat oil in the tank to not over 140 deg. and then have a reheating coil just before delivery to the burner which will give, for mechanical atomizers, about 225 deg., and for steam atomizers, about 175 deg.

If the temperature is kept down to not over 150 deg. in the storage tank, there will be no likelihood of losing suction on the oil pump or of fire danger and the reheating at the burner gives the necessary fluidity for quick atomization.

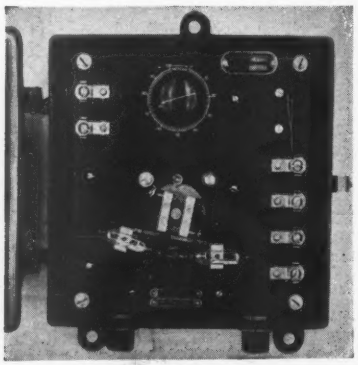
RESEARCH in Government laboratories has indicated that sand-blast mineral grains from specially treated minerals like garnet, corundum, flint, and others of that nature are capable of considerable improvement. Similar modification of grains of minerals so that they give better sand for sand paper is next in order. The abrasive qualities of various pumices and pumicites, tripolis, and quartz sands add to the above to show that research on natural abrasives and polishing minerals would be well-justified.

New Equipment

Anticipating Device for Pyrometer Controllers

THE BRISTOL COMPANY, Waterbury, Conn., has perfected a device known as the B-Linator for use with automatic pyrometer controllers such as are used on industrial heating furnaces. The purpose of this device is to enable the pyrometer controller to anticipate temperature changes and correct the fuel consumption long enough in advance to prevent the temperature from cycling or rising above and falling below the control point as it does because of the thermal inertia offered by the mass of the furnace and the load.

The B-Linator can be used with practically all of the commonly used types of pyrometer controllers and can be added to present installations as well as incorporated in the control circuit of new equipment.

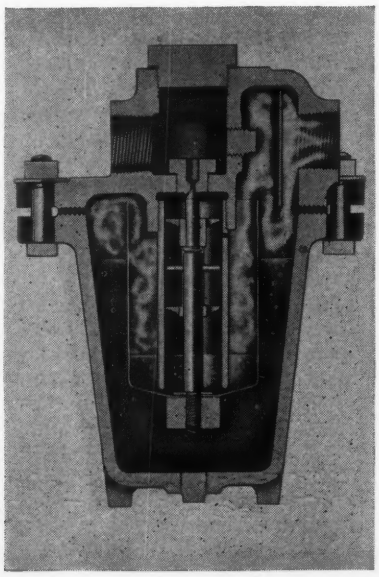


The B-Linator through a switching device adds or subtracts an e.m.f. to the regular thermocouple circuit to cause the controller to act in anticipation of a temperature change. The auxiliary e.m.f. is derived from thermocouples in the B-Linator case connected in series but opposing each other. The magnitude of the e.m.f. produced by these thermocouples is dependent on the temperature change trends.

Cochrane Steam Trap

TO ITS EXTENSIVE line of steam specialties, the Cochrane Corporation, Philadelphia, Pa., has added a new steam trap of the straight-line, bucket type, which is particularly applicable to condensate drainage of steam line, coils, evaporators, jackets, rolls, mixers and stills at pressures up to 150 lb.

Disassembling of the trap for inspection and cleaning without disturbing the piping and connections is made convenient by means of the straight-line method of installation and the plug at the top gives easy access to the seat. Another feature is a vent to prevent air binding. Only two moving parts are included in the trap design: the bucket and the valve. The bucket is independent of the valve stem. A bucket stem, which is fastened rigidly to the bucket, carries a knock-off arm which strikes a guide on the valve stem, knocking the valve from its seat and permitting the condensate to discharge through the full orifice area. This avoids wire drawing and erosion of valve and seat. When trap is in the closed position the condensate collects in the body and overflows into the bucket. While the valve is fast against the seat, the weight of the condensate in the bucket causes the latter to sink.

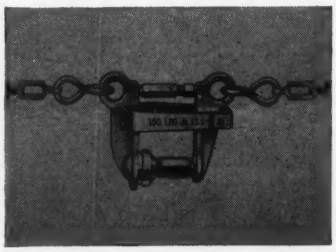


A water seal, provided by the inserted discharge tube, permits bucket to regain buoyancy before complete discharge, snapping the valve shut without blowing steam. The hottest condensate enters at surface of the water, overflowing into the bucket. Any "flash-back" will therefore lighten the bucket and keep trap closed and operative.

The trap body is of molychrome iron, the bucket of drawn copper and valve and seat of hardened stainless steel. The discharge tube and guides are of bronze.

Grinnell "Quartzoid" Link

IN ANNOUNCING the development of the "Quartzoid" Link for heat-operated releasing devices, Grinnell Co., Inc., Providence, R. I., states that this link is capable of carrying loads up to 150 lb., its approved load rating, as compared with 20 lb. for the ordinary solder-type links.



The "Quartzoid" Link is accurate and quick-acting. The bulb, extremely sensitive yet immune to corrosion, completely shatters at its rated temperature. Its ability to carry a load eliminates the necessity of ganging several solder links where unusual weight must be resisted. The new Grinnel Link is intended for conditions of unusual corrosion or weight, or both. At the same time, its sensitivity adapts it to any job where this quality is desired in a heat-operated releasing device.

New Portable Pyrometer

THE BRISTOL CO., Waterbury, Conn., is now offering a new millivoltmeter-type portable indicating pyrometer especially adapted for industrial use. It may be used for measuring temperatures up to 3000 deg. F. using a thermocouple and extension leads.

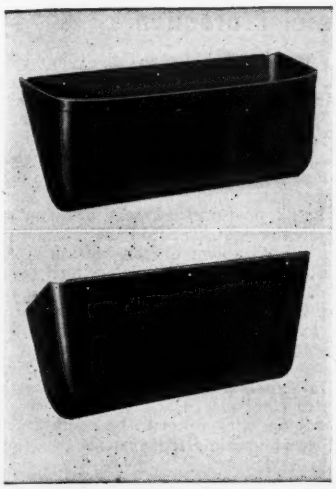
The case is of modern design and is made from molded Bakelite, of moisture and dust proof construction. Increased sensitivity and a widening scale for more accurate readings are two of the design features allowed by the use of a cobalt magnet.

Relay Transformer Sets

A NEW and interesting type of Relay-Transformer Set is announced by Friez of Baltimore. With these sets it is possible to obtain Relays for handling appreciable electrical loads (up to ¾ horsepower or 1000 watts) and also at the same time a transformer at a cost no higher than for a simple Relay alone. In this way, the electrical load to be handled remains on line voltage (which may be either 110 volts or 220 volts) while the control instrument (Thermostat, Humidistat, or Effective Temperature Control or Comfortrol) is at the same time placed on low voltage, thus lowering the cost and ease of installation coupled with greater safety and yet with added control, instrument sensitivity and reliability.

New Elevator Bucket

NOTABLE IMPROVEMENT in the design and construction of Salem steel elevator buckets is announced by Link-Belt Co. Each bucket is reinforced at the digging lip, front corners and along back, to give additional strength and greater resistance to abrasive wear. The reinforcing lip is an integral part of the metal body, folded over and spot-welded along the front edge;

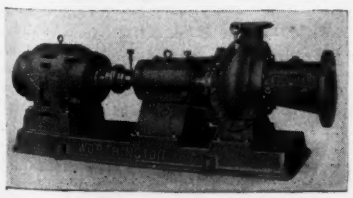


also the back reinforcing plate is spot-welded to the metal body, doing away with rivets. It is unnecessary to use washers on the bucket attachment bolts, since the back of the reinforcing plate presents a flat, smooth surface. These new buckets, in 2½ by 2½ in. to 30 by 8 in. sizes, are interchangeable with the old style and in No. 24 and No. 18 gauge are said to be comparable to heavy construction of the conventional standard Salem design. Folder No. 1435 which gives full information, with list prices, will be sent upon request by Link-Belt Co., Chicago, Ill.

Paper Stock Pumps

IN LINE WITH the present expansion program of the paper industry, Worthington Pump & Mach. Corp., Harrison, N. J., has developed a line of paper stock pumps capable of handling paper stocks of all kinds and consistencies up to 6½ per cent and higher. They are applicable to every paper or pulp manufacturing process requiring a sturdily built, non-overloading, non-clogging, non-air-binding pump for continuous operation. A minimum of suction head is needed and an approximately constant capacity, regardless of changes in suction head, is guaranteed.

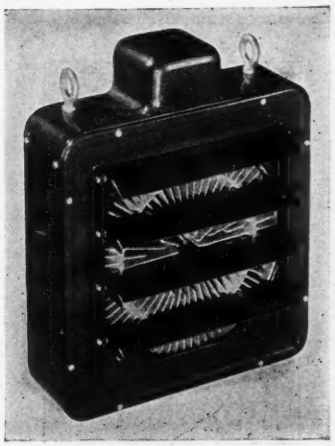
These pumps are made in six sizes. They operate at very low speeds, against



total dynamic heads of 10 to 160 ft., and their capacities range from 100 to 3500 g.p.m. They supplement a complete line of Worthington pumps for the pulp and paper industry.

Industrial Heater

AMERICAN FOUNDRY EQUIPMENT CO. of Mishawaka, Ind., is introducing the Electromode industrial heater through the Electric Air Heater Co. New features are a cast aluminum circular rigid poured around a calrod heating element to eliminate hot wires and dead air space; a 4-blade fan to dissipate heat from all the surface of the grid; adjustable deflectors to direct



the heated air currents; thermal safety switch to prevent overheating, and thermostatic control to maintain constant temperature. Mounting may be on floor, wall or ceiling.

New Permochart

FOR USE in cases where ordinary paper charts are destroyed after one day's use a new recording meter chart has been announced by Permochart Co., Koppers Building, Pittsburgh, Pa. It is called

Permochart, and the smooth, hard-surfaced chart, made from a recently developed wrinkle-proof, waterproof, non-inflammable material, can be cleaned by the use of a damp cloth.

New Industrial Compressor

IN THIS heavy duty machine, which is built for any type of drive but has best economy with a built-in motor, dual-

cushion valves are used. It is built in sizes of 378, 480, 642 and 800 cu. ft. per min., and occupies floor space 6 by 8 ft. It can be had in the form of vacuum pump, boosters for steam or gas, for low or high-pressures. It is known as WN-112 compressor, made by Sullivan Machinery Co.

Automatic Temperature Control

THIS NEW unit of the Mercoid Corp., Chicago, Ill., for warm air systems, has double adjustments for high and low points for both fan and overheating limit switches, enclosed in one case and with dial for 50 to 300 deg. F. As the dial revolves, actuated by a bi-metal coil, it shows the temperature in the furnace or duct, thus serving as a thermometer. The fan control switch prevents blowing of cold air into rooms, if the heating system is not operating to warm the air to 120 deg. or more.

Installation may be by a permanent flange on horizontal surfaces or, on inclined surfaces, by a flange adjustable between 30 and 90 deg.

Off and on control for fan and temperature is by Mercoid sealed mercury switches which tilt to make or break contact, the arc on breaking being immediately stifled by inert gases thus preventing oxidation.

Gas Analysis

WM. O. HEBLER CO., Newark, N. J., announces the new Fuel Ratiometer for checking CO_2 and stack temperature of industrial coal, gas and oil-fired boilers. It is composed of an instrument based on the thermal conductivity principle of operation for measuring CO_2 combined with another instrument for measuring stack temperature utilizing the thermo electric principle.

These two instruments have been combined into a portable apparatus which can be conveniently carried from one place to another. A hand aspirator is provided with each instrument together with a combination thermo-couple and gas sampling holder.

The Pyrometer is calibrated for 100 to 1000 deg. F. and the gas gauge for 0 to 20 per cent CO_2. A Milliammeter is provided in the circuit to indicate at all times the battery current being furnished to the cell. No switches are incorporated in the bridge circuit.

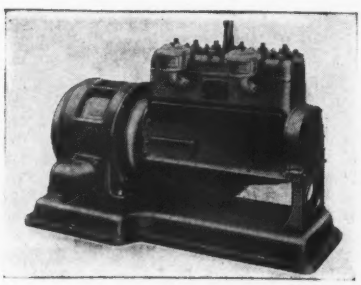
Air Compressor

MODERN AUTOMOTIVE trend of smaller pistons and lighter parts to allow faster piston travel is evidenced in compressor operation by the announcement of a complete line of Utility air compressors by Schramm Inc., West Chester, Pa. Especially designed for installation in industrial plants, the compressors are of the vertical, straightline, cylinder-in-line construction with water ports completely surrounding the entire cylinder area.

Compressor features include a new type of mechanical intake valve, located in the compressor block and operated from the camshaft in timing with the piston travel. Main bearings intersperse every cylinder so that four cylinder models have five bearings and six cylinder models have seven bearings. Forced feed lubrication is used on all main and connecting rod bearings.

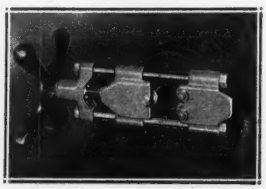
They are offered for either V belt 1800 r.p.m. motor drive or for direct coupling with 1200 r.p.m. electric motors.

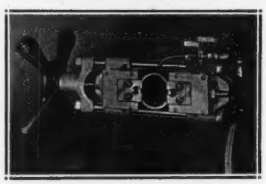
Air deliveries are 85, 105, 160, 210, 315 and 420 c.f.m. actual air delivery with motors from 20 to 100 motor h.p.



Pipe Tools

BEAVER PIPE TOOLS, INC., Warren, O., announces a new development on the Beaver Model A portable unit for cutting and threading pipe and bolts. This is the choice of "wheel-and-roller" or "automatic-knife" cutoff at the same price. The



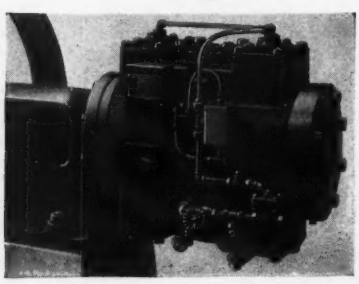


Beaver Model A introduced in 1931 has popularized many mechanical features on portable machines, including rack and pinion feed, quick opening die heads, full ⅛ to 2 in. range, right hand operation and double duty for handling either solid bars or pipe.

Compressor Control

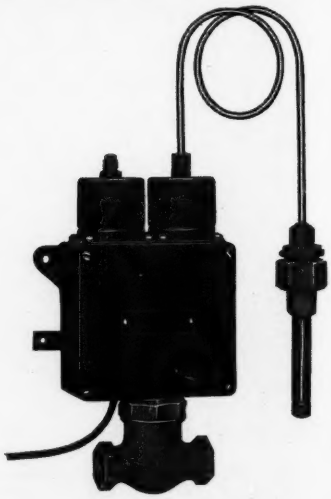
AUTOMATIC start-and-stop control, combined with automatic loading and unloading, can now be obtained without additional equipment on motor-driven, single-horizontal compressors, by using the magnetic unloader introduced by Worthington Pump & Mach. Corp., Harrison, N. J. No extra piping, valves or other devices are required.

This device operates on standard electric equipment and can be installed wherever a conventional automatic starter is used for controlling the compressor motor. The only other provision necessary is a pressure switch to operate a pilot circuit. The pressure switch control is transferred electrically from the motor starter to the magnetic unloader, and either position may be selected at will. If connected to the motor starter, the compressor starts and stops on the demand for air. When connected to the magnetic unloader, the compressor runs continuously and simply loads and unloads depending upon whether or not air is needed. If desired, the cooling water supply can also be automatically controlled. Another feature in the design of this unit permits it to function as a starting and stopping unloader.



Diesel Protection

FULTON SYLPHON CO., Knoxville, Tenn., has developed a Diesel engine safety control No. 530 to meet the requirements of the industry for a simple, non-electric, dependable, self-operated, safety control at moderate cost. This device provides positive engine protection against high packet water temperature and low lubricating oil pressure and may be arranged to stop the engine should the water temperature go above or the lubricating oil pressure go below a predetermined point. Sylphon bellows packless construction has been used throughout and an external lever has been provided for manual operation of control in starting. This lever may be arranged for remote operation if desired and a switch may be incorporated in the case to close electrical contacts when the control operates so as to be connected to audible or visible alarm systems.



Adjustable tripping is provided; provision is made for sealing instrument against tampering; exposed lever gives visual indication of the control; it is enclosed in a sturdy cast brass box with mounting lugs integral.

AS A CONCLUSION to a four weeks' course held at Massachusetts Institute of Technology, Cambridge, Mass., during the latter part of June and first part of July, there will be held a special two day conference on Fatigue and Creep of Metals.

This two day meeting on July 15 and 16 will consist of 14 papers in four sessions. The authors include such well known names as H. J. French; A. Nadai; C. R. Soderberg; D. J. McAdam, Jr.; R. L. Templin; A. V. Karpov; E. L. Robinson; J. J. Kanter; T. McLean Jasper; A. B. Kinzel; H. F. Moore; R. E. Peterson; R. W. Clyne; K. Arnstein; and Dr. H. J. Gough, Superintendent of the Engineering Department of the National Physical Laboratory of England.

Diesel Radiators

EXPANSION JOINTS for Diesel engine radiators has recently been devised which overcomes difficulties arising from the expansion and contraction of metals under varying temperatures. Neoprene, the chloroprene rubber manufactured by the du Pont Co., has been utilized in an expansion joint for copper cores in the Diesel engine radiator manufactured by the Young Radiator Co., Racine, Wis.

In addition to the usual cooling fins, the radiator was designed with eight seamless brass cores or by-pass tubes, four on each side, for additional cooling capacity. The tubes connected the upper and lower tanks of the radiator. Because of the expansion and contraction of these tubes, they pulled away from the header plates, causing leaks in the water system. To overcome the trouble, each tube was cut in three sections, and the sections connected by two short pieces of neoprene hose, which is sufficiently resilient to act as expansion joints and yet resistant to oil and anti-freeze solutions.

Push-Button with Mushroom Head

A SLAP OF the open hand on the "mushroom" head of a new General Electric push-button station (CR2940-2HK1) will suffice to stop a machine controlled by the device. Although developed primarily for use in bakeries where it is important that dough from the operator's hands will not work into the station to interfere with operation, the new station is also particularly suitable for use on machines where it is necessary for the operator to wear very heavy gloves or asbestos mittens. A mushroom head projects from the front of the button so that it is a simple matter for the operator to slap the button when conditions require him to make a rapid, positive shutdown of the machine.

A New Instrument Slide Rule

AN INGENIOUS slide-rule indicator for use in selecting the proper instruments for any application, whether central stations, industrial plants or transportation industry—has been announced by the Westinghouse Electric & Mfg. Co. Called the Instrulector, this slide-rule shows at a glance what instruments to use, their range, approximate price, size, descriptive literature available. The Instrulector is available from the nearest district office or direct from the Advertising Department, 7-N, Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.

Consolidation of Sales Departments

P. R. MORK, vice president in charge of sales, Crane Co. Chicago, announces the co-ordination of all activities concerned with the estimating, engineering, or sale of valves, fittings, pipe, and fabricated piping into one unit, the Valve and Fitting Department, with W. H. Pape as manager. Mr. Pape enters his new position with 25 years' experience covering a wide range of industrial applications of Crane products. His first activity was in heavy railroad construction followed by similar work on New York subways. In 1914 he entered the oil industry serving subsequently as designer, operator, and sales engineer. He joined the Crane organization in 1927 as special representative in New York and later in the Boston territory. For 6 yr. he was in the Oklahoma and Gulf Coast oil fields, and for the past 1½ yr. has been manager of the Oil Sales Department in the general office, Chicago.

The former Industrial Sales Department and Engineering Sales Department are consolidated into a new section—the Engineering Sales Section of the Valve and Fitting Department with E. Burke as manager of this section, G. F. Wright,

W. Howard Pape

assistant manager in charge of estimating and other activities dealing with fabricated pipe and allied products, and W. F. Lahl, assistant manager, supervising the Industrial Zone Men in the field. J. H. Barker is manager of the Sales Quotation Section of the Valve and Fitting Department. Other sections of the new consolidated department include Pipe Sales, Marine Sales, Oil Sales, Railroad Sales, and Water Works Sales.

General Refractories Elects Officers

CHANGES IN organization of General Refractories Co. are the election of S. M. D. Clapper as Chairman of its Board of Directors and of Floyd L. Greene as President.

F. L. Greene

S. M. D. Clapper

Mr. Clapper has been actively engaged in the Company's management since 1933 and will continue in supervision of its policy. He also holds many important executive positions in many other organizations in Philadelphia and Chester, Pa.

Mr. Greene has been active in the refractories field for 25 yr., with the Standard Refractories Co., and since its acquisition in 1922 with General Refractories as district manager of central Pennsylvania, as general works manager, as vice-president in charge of operations, as director, executive vice-president and president. He also acts as director of several subsidiary companies, of American Refractories Institute and as director and vice-president of First National Bank of Claysburg, Pa.

New Flamenol Cable

A NEW SYNTHETIC insulating compound has been recently introduced commercially by the General Electric Company under the trade name Flamenol. While similar to rubber in its characteristics, it contains no rubber and will not support combustion.

Termed the most radical cable development in the last 25 yr., Flamenol is entirely different from any insulation previously available. In addition to being noncombustible it is highly resistant to moisture, acids, alkalies, and oils. It has excellent aging characteristics and is strong mechanically. The properties of Flamenol are such that it can be made a very soft and flexible compound, or made to be one with celluloid-like rigidity. It can be put into solution for coating or impregnating, and can be compounded, filled, calendered, and extruded in much the same fashion as rubber.

Flamenol-insulated cable is recommended for power and control circuits at 600 v. and less, and for operation at a maximum copper temperature of 60 C. It is well adapted to machine-tool wiring, switchboard wiring, and battery and coil leads. Flamenol has a permanently smooth finish and foreign materials do not readily adhere to its surface. It is available in a variety of colors for circuit tracing. For most applications Flamenol is used without any protective finish, such as braid, lead, or armor. It is only where the cable will be subjected to extreme mechanical abuses that such a finish is necessary.

News from the Field

MARTIN RIEGER, JR. has recently joined the New York office of the Foxboro Company, Foxboro, Mass., as a specialist in the Pyrometer Division of that Company. Mr. Rieger is an electrical instrument engineer, formerly connected with the Weston Electrical Instrument Corp.

UNITED STATES RUBBER PRODUCTS, INC., has appointed Dr. Earl G. Sturdevant as Consulting Engineer of its Electrical Wire and Cable Department.

CARL E. SPROUT has been appointed an associate of B. W. Sayer, district manager of the Portland, Oregon, office of the Foxboro Co. Mr. Sprout was formerly in the San Francisco office of the Foxboro Co.

THE BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., announces the appointment of J. P. Boore, effective May 15th, as assistant general sales manager. Mr. Boore has had broad experience in the production and merchandising of seamless steel tubes and pipe. For several years he was vice-president of Summerill Tubing Co., and for 20 yr. prior to that he was associated with the Pittsburgh Steel Co. in various capacities in the production and sales departments.

LUKENS STEEL CO. announces a reduction in price in its Iconel-Clad steel, a heavy plate bonded to a light layer of nickel-chromium alloy, to give resistance to corrosion. A new list of standard extras is also issued.

AT THE Chicago Exposition of Power and Mechanical Engineering to be held Oct. 4 to 9 in the International Amphitheatre, exhibits will be displayed under the following classifications: Fuels; combustion equipment; refractories; steam generating equipment; steam distribution; accessories; piping and fittings; prime movers; pumps and hydraulic equipment; electric generators and motors; electrical transmission, distribution, and control devices; power transmission accessories; instruments of precision; tools and machine tools; power driven units; materials handling systems; factory air conditioning equipment; lubricants; refrigerating machinery; operation and maintenance materials. The exposition is under the direction of Charles F. Roth, Grand Central Palace, New York City.

CHANGES in the organization of the Mercoid Corp. are announced as follows: R. M. Keatts and J. F. McCauley, completing the sales training course, will join the sales staff, Mr. Keatts to work out of Cincinnati and Mr. McCauley from Cleveland. William Ufer and Walter Lischett, for several years in factory and service work, are transferred to the sales department in the Chicago office. J. F. Chambliss, formerly with E. F. Gore & Co. has been appointed auditor.

NATIONAL RADIATOR CORP. is taking a unique method to announce its new line of heating and air conditioning equipment. Sales meetings will be held in 12 cities by a force including W. B. Montague, sales promotion and advertising manager, T. A. Novotney, manager of convector sales; J. T. Ellis, manager of steel boiler sales and E. L. Redden, assistant sales promotion and advertising manager, a complete equipment being used to present the sales features, mounted on a traveling stage with special lighting effects.

TO PROVIDE better service facilities for its customers in the southwestern territory, Cutler-Hammer, Inc., Milwaukee, has opened a new sales office at 624 Santa Fe Building in Dallas, Texas, where a stock of its standard apparatus will be carried.

WORTHINGTON PUMP AND MACHINERY CORP. has announced the appointment of J. J. Summersby, Assistant Vice-President as General Sales Manager of that Corporation. Mr. Summersby joined the Corporation as a sales engineer immediately after his completion of post-graduate work at Washington University in 1920, and has since then served as district sales manager, divisional sales manager and assistant general sales manager.

FREDERICK G. BANNING, formerly with scientific apparatus department of Cornell University Medical College, has become associated with Designers for Industry, Inc., Cleveland, Ohio, industrial designers and product stylists, as chief engineer in charge of engineering development. Mr. Banning will also supervise the mechanical and technical qualities of designs originating in the firm's New York and Chcago offices.

C. C. JORDAN, Sales Engineer for the past ten years in the Steam Turbine Division, Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin, has been appointed Assistant Manager of that Division.

WARD LEONARD ELECTRIC CO. announces the appointment of J. Y. Dahlstrand as special representative to handle the sale of Automatic Alternator Voltage Regulators.

Mr. Dahlstrand has been associated in engineering capacities on turbo generators and other power plant equipment with Allis-Chalmers Mfg. Co., Westinghouse Electric & Mfg. Co., and for a number of years as chief engineer for the Kerr Turbine and Murray Iron Works Companies.

Mr. Dahlstrand's offices are at 1719 South Street, Burlington, Iowa.

E. J. GOVE has been placed in charge of a new Cutler-Hammer office, a branch of the Pittsburgh office, recently opened in Youngstown, Ohio, at 1106 Central Tower, Telephone 66091. Mr. Gove has been located in Youngstown for a number of years and the new office will give him headquarters facilities and provide better service for the company's customers in the Youngstown area.

THE LONG ISLAND LIGHTING SYSTEM reported completion of arrangements for installation of a new 75,000-kw. turbo-generator unit in its station at Glenwood Landing, N. Y., bringing the capacity of the station to 170,000 kw. The generator unit will be supplied by General Electric Co. and the condenser by Westinghouse Electric and Manufacturing Co.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has moved its Chicago offices to 433 East Erie St. to secure larger quarters.

W. A. JONES FOUNDRY & MACHINE CO. announces that its Buffalo, N. Y. office, in charge of Frank W. Stuker, is now located at 361 Delaware Avenue, in the Curtiss Building.

CHARLES W. E. CLARKE has rejoined the staff of United Engineers & Constructors, Inc. as Consulting Engineer with headquarters at 1401 Arch Street, Philadelphia, Pennsylvania.

YARNALL-WARING CO., Philadelphia, announces the appointment of J. S. Fanning as assistant to Roger A. Martin, Yarway sales representative in the Atlanta territory.

A. J. GOEDJEN, division manager and A. C. Carson, chief engineer, both of Green Bay, Wis., have been elected members of the board of directors of the Wisconsin Public Service Corp., according to J. P. Pulliam, president of the company.

Mr. Goedjen, a graduate of the University of Wisconsin previously employed by the General Electric Co., Commonwealth Edison Co., The Milwaukee Electric Railway & Light Co., and the Merchants Heat & Light Co. joined the Wisconsin Public Service Corporation in September 1916, and was appointed manager of the Green Bay division in 1928.

Mr. Carson has been associated with the corporation since 1918 following experience with the Grand Rapids, Grand Haven & Muskegon Railway Co. and the Winnebago Traction Co.

During his first year with the Public Service Company he supervised the construction of the Manitowoc steam plant, in April, 1925, he was appointed manager of the Green Bay division and in January, 1927, was named chief engineer for the entire company.

THE MINE SAFETY APPLIANCES CO., Thomas and Meade Streets, Pittsburgh, Pa., have published a new bulletin describing their MSA All-Service Gas Mask (Burrell Type). The Mask is designed to provide protection against asphyxiation from combinations of carbon monoxide and all other poisonous industrial gases, fumes and smoke.

ELMER MILLER COAL CO., sales agent of Appalachian Coals, Inc., for The Beaver Coal and Mining Co. announces completion of a new tipple at Drift, Ky., with vibrator screens, vapor oil-treating equipment, crushers and electromagnets to provide Milco manufactured stoker coal. Resumption of operations at the mine was scheduled for June 1. A. B. Richardson, secretary of Elmer Miller Coal Co., has headquarters in the Richardson Bldg., Toledo, Ohio.

REMOVAL of its New York Office to larger quarters at 61 East Eleventh Street is announced by the Ideal Commutator Dresser Co., Sycamore, Illinois. The new quarters include a completely equipped showroom with modern all-steel shelves and showcases on which the Ideal products are displayed in a most effective manner. Features of the showroom are the Action Displays of Ideal Products.

WISCONSIN PUBLIC SERVICE CORP. of Milwaukee has declared intention to replace the timber and rock-fill dam at Tomahawk, Wis., with a concrete structure and construct a power plant and substation at the west end of the dam, having two vertical units of 2000 hp. each under 16 ft. head and a 3000 kv-a. substation to supply energy for public utility uses.

Garlock Celebrates 50th Anniversary

THIS YEAR is the Golden Anniversary of The Garlock Packing Co., for it was just 50 yr. ago that this company began the manufacture of mechanical packings at Palmyra, New York.

It was in this village, shortly after the close of the Civil War, that one of the founders of The Garlock Packing Co. conceived the idea of making mechanical packings by cutting a ring from an old piece of rubber hose and putting it in a stuffing box of an engine used to furnish power to a saw mill. The experiment proved to be so successful that similar packing rings and washers were cut from a supply of the same material and sold to the different users of steam engines throughout the vicinity.

This was the beginning and nucleus of the mechanical packing business. In the year of 1887. The Garlock Packing Company was founded and, with a handful of employees, started the first manufacture of mechanical packings on a commercial basis. Today Garlock has over 1000 employees. The general offices and factories shown here are located at Palmyra, N. Y., sales offices and warehouses are maintained in 22 principal cities of the United States, and branch factories are operated at Birmingham, Ala., Denver, Colo., and San Francisco, Cal. The Canadian factory is located at Hamilton, Ont., and sales offices and warehouses are maintained in six leading Canadian cities.

ARCTIC HYGEIA ICE MFG. CO., 133rd St., New York City, is now owned by the Jacob Ruppert Realty Corp., who contracted in December with the Frick Co. of Waynesboro, Pa., for complete modernization of the immense freezing system. Six new welded freezing tanks, each containing 1275 all welded ice cans, have been installed. The cans are arranged in grids lifting 25 at a time. There are 12 large shell-and-tube brine coolers, each 46 in. in diameter; 12 float controls and accumulators; 12 motor-driven agitators; 6 sets of dump boards, dip tanks, and can fillers; 3 sets of dehydraters; 6 two-motor cranes with I beams for runways; pumps, tank insulation; 300 tons of salt, etc. The total weight of the equipment which is being delivered and erected by Frick Co. is close to 3,000,000 lb.

JOHN O. SMITH has accepted appointment as acting chief of the marketing division, National Bituminous Coal Commission, Washington, D. C.

For 20 yr. Mr. Smith was with the Southern Railway in passenger, freight and operating departments, then went with H. L. Miller, president of Interstate R. R. In 1921 he was elected president of Central Supply Co., Andover, Va., in mine and mill supplies and in November 1922 he became sales manager of Stonega Coke & Coal Co. When the General Coal Co. was formed in 1924 to market admiralty and Crozier southern high-volatile coals, also Westmoreland and Hazelbrook, Pennsylvania anthracites, Mr. Smith was appointed southern sales manager with headquarters at Charlotte, N. C. He remained with General Coal Co. until 1933 when he joined the marketing staff of Appalachian Coals, Inc., with whom he has been until now.

His work will be an important part of organizing the 23 district boards of coal members and later to hear complaints and adjust differences which are referred to the National Board. As a first work, Mr. Smith states, "My chief duty will be to supervise establishment and classification of prices under the Bituminous Coal Act; also correlation of prices among the 23 districts to be established."

TO MEET DEMANDS for giving engineers a broad cultural training and careful preparation for professional work, the Faculty of the University of Detroit (Mich.) has defined as its general aims: To give a college education that will prepare for a career in professional standing in the field of engineering; to prepare especially for industrial and administrative work; to qualify for a useful, happy life as men and citizens as well as engineers, and give an appreciation of social, civic and cultural values. To carry out these aims, curricula are to be arranged: To give a thorough basic foundation in engineering sciences; to qualify for professional standing and for examination by state boards of examiners; to provide foundation in non-technical subjects that will fit the graduate to progress to managerial positions; to give practice in sound planning and analysis; to give appreciation, through association with practicing engineers, of what constitutes professional atmosphere and of economic aspects of engineering; to develop facility and knowledge of instruments and their uses by laboratory training; to give flexibility of mind, imagination and an appreciation of human factors in industry. Each department is to work out revisions of its courses to bring them into line with the above plan and objects.

HARALD M. WESTERGAARD, who was named Gordon McKay Professor of Engineering at Harvard last fall, following 20 yr. on the Engineering faculty of the University of Illinois, has been appointed Dean of the Harvard Graduate School of Engineering. In this new post he succeeds Dean Harry E. Clifford, who became emeritus this year. A specialist in the engineering problems connected with reinforced concrete, Professor Westergaard has been a technical expert for the federal government on various construction projects, including Boulder Dam. Born in Copenhagen, Denmark, in 1888, Professor Westergaard received his early education in his native country, and did post-graduate university study in Germany and the United States. His degrees include B.S. Royal Technical College, Copenhagen, 1911; and Ph.D. University of Illinois 1916. He holds honorary degrees from the Royal Technical College of Copenhagen, and Lehigh University.

A. S. M. E. Nominations

THE REGULAR NOMINATING COMMITTEE of the Society presents the following nominations for officers of The American Society of Mechanical Engineers for 1938:

President, H. N. Davis, President, Stevens Inst. of Technology, Hoboken, N. J.; Vice-Presidents (To serve 1 year), F. O. Hoagland, Master Mechanic, Pratt & Whitney Division, Niles Bement-Pond Co., 436 Capitol Ave., Hartford, Conn.; (To serve 2 years), B. M. Brigman, Dean, Speed Scientific School, University of Louisville, Louisvlle, Ky.; Harte Cooke, Mechanical Engineer, McIntosh & Seymour Corp., 100 Orchard St., Auburn, N. Y.; W. H. McBryde, Cons. Engineer, 1111 Financial Center Bldg., San Francisco, Calif.; L. W. Wallace, Director, Equipment Research, Association of Am. Railroads, 59 East Van Buren St., Chicago, Ill.; Managers (To serve 3 years), Carl Bausch, Vice-President, Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.; S. B. Earle, Dean, School of Engineering, Clemson A. & M. College, Clemson College, S. C.; F. H. Prouty, Partner, Prouty Brothers Engrg. Co., Exchange Bldg., Denver, Colo.

Election will be held by letter ballot of the entire membership, closing on September 28, 1937.

ALLIS-CHALMERS MFG. CO. has opened an office in the National Bank Building, Knoxville, Tenn. in charge of W. C. Johnson. This office will operate as a branch of the Company's Chattanooga District Office of which D. S. Kerr is Manager.

HOMESTEAD VALVE MFG. CO. announces the appointment of Warren Bruce & Co., 3908 Olive Street, St. Louis, Mo. and Proctor Engineering Co., Inc., 106 Key Highway, Baltimore, Md. as representatives for the sale of their complete line.

J. F. LINCOLN, president of The Lincoln Electric Co., and in whose honor was created The James F. Lincoln Arc Welding Foundation, is in England giving a series of talks at the invitation of various engineering societies and institutes, including the South Wales and Monmouthshire Institute of Engineers, the Institute of Engineers and Shipbuilders of Scotland, the Institute of Mechanical Engineers in London, and others. Mr. Lincoln's invitations to speak in England were prompted by growing interest, on the part of British firms and societies, in the application and use of electric welding in manufacture and construction.

For the Engineer's Library

ELECTRIC POWER IN THE U. S. S. R. Prepared by the U. S. S. R. Committee for International Scientific and Technical Conferences. Published by International Publishers, New York, N. Y., size 6 by 9 in., 490 pp., cloth bound. Price $3.00.

Specific features of planned electric power development in Russia covered by this volume was prepared for the Third World Power Conference. In the decade from 1925 to 1935 generating capacity increased over 600 per cent and the power consumption almost 900. Many of the newer stations utilize low grade local fuel and the early days in the development program are of interest to all nations with large supplies of peat lignite and brown coal.

Transplanting the art of power generation to a practically undeveloped country involved difficulties of an engineering, manufacturing and design nature and coordination of fuel resources which are now well on the road to success. One of the major problems, as yet not entirely solved, was the coordination of hydro and steam power. This involves changing the course of several major rivers in such a way as to take care of power, transportation, fishing and agricultural needs of the nation. In general this consists of diverting drainage of the southern watersheds eastward and from the northern watersheds toward the south. In this gigantic undertaking, power is but one of a large number of factors to be considered. The book covers the entire electrification program, is well illustrated and makes interesting reading.

FREEHAND AND PERSPECTIVE DRAWING, by Herbert E. Everett, Professor of History of Art, University of Pennsylvania, and William H. Lawrence, Professor of Architectural Engineering and Chairman of Division of Drawing, Massachusetts Institute of Technology. Published by the American Technical Society of Chicago. Size 9 by 6 in., 72 pp., cloth bound. Fourth edition, 1937. Price $1.50.

Due to the authors' knowledge of the subject and the methods of teaching, they have been able to give the reader an adequate conception of the correct methods of drawing. In the freehand section materials and tools are first discussed, followed by some simple exercises in line formation, perspective and shading. The section on perspective drawing is of analytical nature dealing with rules, planes of perspective and the vanishing point which are well worked out. The book will undoubtedly be a great help to any reader who is truly interested in the subject.

PRINCIPLES OF ECONOMIC HEATING is a 60 page, 6 by 9 in. paper bound volume, prepared by the Commercial Relations Committee of the National District Heating Association in collaboration with the National Association of Building Owners and Managers. No effort has been spared by the committee to make this complete and authoritative. The general chapter headings cover heat losses from buildings, short-hour heating, temperature control, methods of regulation and methods of savings, common faults and corrections, and control equipment. It may be obtained from the headquarters of the N.D.H.A., 1317 Spruce St., Philadelphia. The price is 25c per copy with special reductions for quantity lots.

THE TESTING OF INTERNAL COMBUSTION ENGINES. By S. J. Young and R. W. J. Pryer. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City. Size 6 by 9 in., cloth bound, 197 pp. Price $3.25.

There has been a definite need for a small text book dealing with the testing of internal combustion engines from the point of view of the technical school or laboratory with an interest which extends beyond the simple determination of rating and fuel consumption. The authors, in this book, have supplied that need largely from results of their own work at the Internal Combustion Engines Laboratories of Loughborough College, England. As such the book deals, not with large engines, but with those usually found in laboratories of that type. Many of the methods described were evolved by the authors and much of the apparatus described was made within their own work shop, so that, it is well within the capabilities of the average engineering student.

Chapter headings include: Introduction; engine timing; brake horsepower tests; fuel consumption tests; indicator tests and applications of the indicator diagram; heat losses; the measurement of air consumption and volumetric efficiency; and miscellaneous experiments.

In the foreword, by H. R. Ricardo well known development engineer, the need for more extensive tests and testing technique is pertinently set forth: "We place an engine on a test-bed, couple it to a dynamometer and a fuel-measuring device, and start it up; it makes an unconscionable noise and seems inordinately busy. The dynamometer and speed indicator tell us more or less the power it is giving, usually an acute disappointment, and the fuel-measuring device tells us how much fuel is disappearing down its gorge; that much is easy, but of very little real value, for what in truth we want to know is not so much the power it is giving, but just exactly why it is not giving a great deal more."

MAN IN A CHEMICAL WORLD. By A. Cressy Morrison. First Edition. Illustrated, cloth, 6¾ by 9¼ in. Charles Scribner's Sons, 597 Fifth Ave., New York, N. Y., 1937. Price $3.00.

The preparation and publication of this volume was authorized as a result of the success of the celebration of the Three Hundredth Anniversary of the founding of the chemical industry in the United States in 1635 by John Winthrop. It is designed to place before the public in simple language, the contributions of the chemical industry not only to the well being of the individual but as a contributor to human comfort, protection and the advancement of civilization. The Executive Committee of the American Chemical Industries Tercentenary appreciated the possibilities and usefulness of such a volume and, under the auspices of the Committee, Mr. Morrison was delegated to produce it. The book is beautifully designed with numerous pen and ink plates symbolizing the power of chemistry in civilization, by Leon Soderston. For the student who is considering a career in science, and especially for those who have the responsibility of vocational guidance this book should prove helpful.

BULLETIN 500-2 issued by the Northern Blower Co., Cleveland, Ohio, describes the "Norblo" sound type air filters which are automatic and designed for continuous service.

How FUEL costs in the generation of power can often be reduced by 25 to 50 per cent is pointed out in a paper entitled Power and Heat Problems Yield to Improved Alloys and Designs by C. R. Waller, vice-president in charge of engineering, of the De Laval Steam Turbine Co., Trenton, N. J. By using steam at high pressures and temperatures, the efficiency of condensing steam plants can be greatly increased, and where steam is used for processing or heating, large amounts of power can also be obtained as a by-product, using the turbine as a pressure reducer and heat distributor. The possible savings with steam at various pressures and temperatures are presented in a table. The paper can be obtained from the company.

"THE WELDING OF ENDURO STAINLESS STEEL" is a new 20-page booklet published by Republic Steel Corporation, Cleveland, Ohio. The booklet describes in detail by words and pictures the proper methods for welding stainless steel by electric arc, gas, seam, spot, projection and atomic hydrogen methods. Also included is information on brazing and silver soldering. An interesting feature is a table showing in condensed form the physical, electrical and mechanical properties of thirteen of the more important types of Enduro Stainless Steel, contrasted with similar properties of a carbon steel, S.A.E. 1020.

A NEW BOOKLET, "The Story of the Solenoid Starter," has recently been published by The Allen-Bradley Co. of Milwaukee, Wis.

This 24-page, 2-color booklet brings out, by questions and answers and numerous sketches, the fundamental differences between the solenoid type motor starter and the conventional clapper type starter. The booklet points out, in simple terms, the reasons why the solenoid starter was developed, and tells of its unusual performance. In addition, many typical applications of solenoid motor control are illustrated and a brief resume of the Allen-Bradley line is given.

THE TWO ELEMENT SINGLE DISH WATTHOUR METERS is the subject of a new General Electric Co. Bulletin, designated GEA-2404A.

THE TERRY STEAM TURBINE CO., Hartford, Conn., has just issued Bulletin S-116 entitled "The Terry Wheel Turbine." This describes the details of construction and the principles of operation of Terry Wheel Turbines.

A COMPACT presentation of the Worthington line of vertical, single-cylinder, single-stage, air-cooled and water-cooled compressors is offered in an illustrated eight-page bulletin, designated L-621-B5.

Sectional views showing important features of construction, detailed specifications of the feather-type valves and other principal elements, rating tables, and dimension tables, are included.

Bare compressors, and base-mounted units with motor and V-belt drive, are covered in the tables. Illustrations show also units complete with vertical or horizontal air receiver, direct-connected to electric motor, direct-connected to gasoline engine, and three-cylinder and six-cylinder, angle-type, two-stage units in various arrangements.

SEVERAL NEW bulletins on recording and controlling gages have just been published by The Bristol Co., Waterbury, Conn. These are bulletins No. 483, No. 484, No. 485, and No. 486. Copies will be sent to anyone interested in the subject of gages.

FOSTER WHEELER CORP., 165 Broadway, New York, N. Y., announces Bulletin X-37-4, the first piece of literature describing the new Type S stainless steel bellows expansion joint announced to the public at the New York Power Show last December.

INDICATING THE DIESEL ENGINE has been reprinted by the Bacharach Industrial Instrument Co. from the Diesel Handbook. Copies of this 25 page booklet may be obtained from the company at 7000 Bennett St., Pittsburgh, Pa.

COOLING THE DIESEL ENGINE is a 27 page reprint from the Diesel Handbook being distributed by the Cooling Tower Co., Inc., 15 John St., New York, N. Y.

BULLETIN 5601 recently published by Ward Leonard Electric Co., Mt. Vernon, N. Y., describes and illustrates the Electronic Regulator which can be used with any known method of excitation. It explains in complete detail, the operation of this comparatively new method of automatic, voltage regulation.

BULLETIN 5602 describes and illustrates a similar Regulator designed for only one scheme of excitation, that is, one regulator for each exciter. Generators can be paralleled. Both regulators are quick response types, corrective action starting within ½ and one cycle, respectively, of any change in alternator voltage.

THE INTERNATIONAL NICKEL CO., INC., has issued several new leaflets, all of which should be of interest to power plant operators. "Making Old Pumps Good As New" describes methods of extending the life of worn pumps by the use of novel metal fittings. "Valves trimmed with Monel metal" describes valves for use with temperatures up 750 deg. A third leaflet is entitled "Gaskets" and this describes the making of joints for pressures up to 1375 lb. per sq. in. and temperatures up to 850 deg. F.

"ZEOLITE PROCESS for Treating Boiler Feed Water" is the title of a new 68 page booklet issued by The Permutit Co., 330 W. 42nd St., New York, N. Y. This is an attractively designed booklet presenting authoritative information on recent developments in the field of boiler water conditioning. It was written primarily to supply accurate information on the application of zeolite water softening to boiler feed water treatment. An informative and interesting booklet of value to all power plant operators. It is sent free to those wishing copies.

"KEEPING A. C. MOTORS IN OPERATION" is the title of Bulletin 237 just issued by the I-T-E Circuit Breaker Co. of Philadelphia, Pa. This bulletin describes circuit breakers equipped with the new I-T-E Thermo-magnetic Overload Feature which is designed to provide A-C motors with complete overload and short circuit protection while preventing needless shutdown.

THE BRISTOL CO., Waterbury, Conn., has recently published a 40-page catalog on electrical and mechanical flow meters. Flow meters are discussed in detail as to construction, use and operation, using Bristol's Metameter principle of telemetering. It also contains useful engineering data for reference.

IDEAL COMMUTATOR DRESSER CO., Sycamore, Ill., has issued a new catalog entitled Ideal Motor and Other Maintenance Equipment, Electrical Specialties, giving up-to-date information on commutator and slip-ring maintenance.

INQUIRY ON COOPERATIVE ENTERPRISE, Washington, D. C., has published a report on Cooperative Enterprise in Europe for 1937. It has 321 pages and is paper bound, selling for 65 cents by the Superintendent of Documents, Washington, D. C.

REFRACTORY & INSULATION CORP., 381 Fourth Ave., New York, N. Y., has a new bulletin on Stic-Tite, a reclaimable, nonshrinking plastic material for heat insulation of large, small and irregular surfaces at temperatures up to 1800 deg. F.

ALEXANDER BROTHERS, INC., Philadelphia, have published Catalog A-117 which is entitled Tentacular Drive Data. It has 32 pages and presents in simple and understandable form the engineering data underlying tentacular belting which is claimed by the manufacturers to be the most highly efficient transmission belt that is known to mechanical power transmission engineering.

QUIMBY PUMP CO., 340 Thomas St., Newark, N. J., has recently published an 8 page bulletin, R-300, on Quimby Rotex pumps which have proved exceptionally efficient on handling fuel oil and lubricating oil for oil systems in power plants.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., devotes an attractive new and revised 12 page bulletin No. 1476A to the subject of coal screens, giving illustrations of various types of vibrating screens, representative installation views, as well as sizes and dimensions.

THE STORY of Plastic Molding is told in a 40-p. booklet issued by Chicago Molded Products Corp., 2145 Walnut St., Chicago, Ill. It shows the method of manufacture, gives hints on design of parts and illustrates standard and special products for all sorts of uses.

BALDWIN-SOUTHWARK for May, a publication of Baldwin-Southwark Corp., Philadelphia, Pa., covers a wide range of the corporation's products. Propeller type turbines at Wheeler Dam built by the I. P. Morris Division, plastic filling materials for dental service by the L. D. Caulk Co., De La Vergne Diesel engines, Southwark presses for wood pulp, for briquettes of coal and of steel and iron scrap, and for plastic materials, and methods of training inspectors for testing concrete are among the subjects treated in the articles.

LOWER FURNACE Operating Costs with Johns-Manville JM-20 Insulating Brick is the title of a folder showing application of this brick to twelve modern types of industrial furnaces, and giving a table of heat losses through walls of bare fire brick and through those with insulating brick. Physical properties of the brick are defined. It is designed for use behind refractory walls or for direct exposure to temperatures up to 2000 deg. F. where there is no flame impingement, slagging action or mechanical abrasion. The folder is issued by Johns-Manville, 20 East 40th St., New York City.

CUTTING MAINTENANCE costs of industrial roofing and siding is discussed in the new 12-p. brochure, J-M Corrugated Transite published by Johns-Manville, 22 East 40th St., New York City. Drawings show construction details, and special accessories to seal joints and ridges and typical installations are pictured.

VIBRATION study by use of the Neobeam oscilloscope and the application of different models of that instrument for tests of motors, gears, bearings, noise and smooth surfaces are given in a folder issued by Sundt Engineering Co., 4238 Lincoln Ave., Chicago, Ill.

REPRESENTATIVE refrigerating and air conditioning installations for a score of different applications are listed in a 24 p. bulletin No. 512 B issued by the Frick Co., Waynesboro, Pa. Other new catalogs include Bulletin 234 describing evaporative condensers, and Bulletin 200-D describing a new purger both applicable to ammonia or Freon refrigerating systems.

INDICATING pressure and temperature controllers manufactured by the Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass., are described in a new bulletin, No. 2500 D, recently issued.

PICTORIAL of Welding Progress is an interesting 8-p. bulletin issued by Lincoln Electric Co., Cleveland, Ohio.

NORTON CO., Worcester, Mass., has issued its Bulletin No. Five on Handling Heat which is devoted to alundum and crystolon refractories as applied to kiln linings and furniture.

NICHOLSON INDUSTRIAL steam traps are made the subject of Bulletin No. 337 issued by W. H. Nicholson Co., 12 Oregon St., Wilkes-Barre, Pa. In this bulletin are given tables of sizes of various types of traps, recommended operating conditions, piping diagrams and details of exclusive features of these thermostatic traps.

MULTIPLE-ORIFICE flow-meters of U-tube type, suitable for a wide range of flows at pressures from 200 to 600 lb. per sq. in., are described in Bulletin No. 5 of The Meriam Co., Cleveland, Ohio.

DE LAVAL STEAM TURBINE CO., Trenton, N. J., is distributing a four page folder giving the story of the Louisville, Ky., flood from the standpoint of the Riverside Pumping Station. A steam driven De Laval unit was kept in operation throughout the flood by steam from a river steamboat moored alongside of the pump house. A motor driven unit was quickly reconditioned and put back in service after being buried 10 days under 35 ft. of water.

GOULDS PUMPS, INC., Seneca Falls, N. Y., has published a new catalog covering its broad lines of centrifugal, reciprocating and rotary pumps for industrial service. Each pump is presented completely with description, illustrations, specifications, ratings and when desirable, dimensions. The new book, 80 pages thick and attractively covered, is a real guide for those interested in pumps for industrial use.

Power Plant Construction News

Ala., Birmingham—Birmingham Paper Co., Fifth Avenue South and Twenty-first Street, plans installation of electric power equipment in a new three-story and basement addition to paper-converting plant. Entire project will cost over $150,000. Proposed to begin work soon. Charles H. McCauley, Jackson Building, is architect.

Ala., Huntsville—Southern Metal Products Corporation, Huntsville, plans installation of electric power equipment in new additions to stove and range-manufacturing plant, comprising three one-story units, 20 x 200 ft., 30 x 120 ft., and 60 x 100 ft., respectively. Entire project will cost close to $100,000.

Calif., Los Angeles—Johns-Manville Corporation, 22 East Fortieth Street, New York, N. Y., plans installation of electric power equipment in new insulating products manufacturing plant at Los Angeles, where tract of land has been acquired in suburban district. It will comprise several large units. Entire project will cost about $1,000,000.

Calif., Santa Paula—Limoneira Co., 117 North Tenth Street, plans installation of power equipment in new addition to fruit-packing plant. An air-conditioning system will be installed; also mechanical-handling equipment. Entire project will cost close to $85,000. Roy C. Wilson and Geoffry N. Lawford, Say Road, are architects.

Conn., Meriden—Connecticut Gas Products, Inc., New Haven, Conn., plans installation of power equipment in proposed new plant on Main Street, South Meriden, Conn., where site is being acquired. Entire project will cost close to $100,000. George J. Fouser, vice-president, is in charge.

D. C., Washington—Bureau of Yards and Docks, Navy Department, Washington, will receive bids until July 14 for diesel-electric generating equipment installed on pontoon at Navy Yard, Pearl Harbor, T. H.; also for crane dredge for same yard (Specifications 8491).

Fla., Tampa—American Can Co., 230 Park Avenue, New York, N. Y., plans installation of electric power equipment in new addition to branch plant at First Avenue and Twenty-second Street, Tampa. Work is scheduled to begin soon. Entire project will cost over $300,000. C. G. Preis is company engineer, in charge.

Ill., Aurora—National Brush Co., Illinois Avenue, plans installation of power equipment in new addition to local plant, two-story, 70 x 200 ft. Company will also make extensions in steam power house, including installation of additional equipment. Proposed to ask bids early in July. Cost over $80,000. Frank B. Gray, 73 South La Salle Street, Aurora, is architect.

Ill., La Grange—Electro-Motive Corporation, La Grange, manufacturer of large Diesel engine units for locomotive service, plans installation of electric power equipment in new one-story plant addition, 360 x 816 ft. Entire project will cost about $1,000,000. H. L. Hamilton is president. Company is a unit of General Motors Corporation, General Motors Building, Detroit, Mich.

Ind., Anderson—Delco-Remy Division, General Motors Corporation, plans installation of electric power equipment in new one and two-story addition to automobile starting and lighting equipment manufacturing plant. Entire project will cost over $200,000. Work is scheduled to begin soon.

Ind., Decatur—Board of County Commissioners, Court House, Decatur, is considering extensions and improvements in steam power house at local court house and jail, including installation of new boiler units and auxiliary equipment. County engineer will be in charge.

Ind., Indianapolis — International Harvester Co., 606 South Michigan avenue, Chicago, Ill., plans installation of electric power equipment in new plant on Brookville Road, Indianapolis, for production of gasoline engines for motor trucks. It will consist of several units. A power plant will be built for works service. Entire project will cost over $3,500,000.

Ind., Whiting—Globe Roofing Products Co., Inc., 176 West Adams Street, Chicago, plans installation of power equipment in new plant at Whiting, where large tract of land has been acquired. A steam power house will be built for works service. Entire project is reported to cost over $100,000. Abbott Coburn is president.

Iowa, Bellevue—City Council plans early call for bids for extensions and improvements in municipal electric power plant, including new 1500-hp. Diesel engine-generator unit with accessories, switchboard and miscellaneous equipment.

Iowa, Primghar—Common Council has plans maturing for new municipal electric light and power plant. A bond issue of $125,000 has been approved for building and equipment.

Iowa, Knoxville—Construction Service, Veterans' Administration, Washington, D. C., will receive bids until July 13 for new boiler plant at institution at Knoxville, including boiler units and auxiliary equipment, radial brick stack, etc. Entire project is estimated to cost about $175,000.

Kan., Sedgwick — Common Council plans installation of a municipal gas distributing system. Cost about $25,000. A bond issue in such amount is being arranged and work will be placed under way shortly thereafter. F. F. Devlin, W-K-H Building, Wichita, Kan., is consulting engineer.

La., Spring Hill—Southern Kraft Corporation, 220 East Forty-second Street, New York, N. Y., a subsidiary of International Paper Co., same address, plans installation of electric power equipment in new branch kraft pulp and paper mill at Spring Hill, about 50 miles from Shreveport, La., where large tract of land has been acquired. It will comprise several units. A power house will be built. Entire project will cost close to $6,000,000. Completion is scheduled early in 1938.

Md., Baltimore — James Distillery, Inc., 807 Key Highway, plans installation of electric power equipment in new three-story addition to liquor rectifying and bottling works. Entire project will cost over $75,000. Work is scheduled to begin soon.

Mich., Stambaugh — City Council, Charles A. Nelson, city manager, is considering construction of a municipal electric light and power plant, and will have estimates of cost made in near future. It is proposed to hold an election in fall to vote bonds for project. (A number of months ago, municipality had surveys made for station by Federal Engineering Co., Central Office Building, Davenport, Iowa, consulting engineer.)

Minn., Adrian—City Council is considering extensions in municipal electric power plant, including installation of new Diesel engine-generator unit and accessories. Druar & Milinowski, Globe Building, St. Paul, Minn., are consulting engineers.

Minn., Madelia — Common Council has plans under way for new municipal electric power plant, including installation of Diesel engine-generator units and auxiliary equipment. An electrical distributing system will be installed. Plans and estimates of cost are being made by Burlingame, Hitchcock & Estabrook, Inc., Sexton Building, Minneapolis, Minn., consulting engineer.

Mo., Rockport—City Council has plans for new municipal electric light and power plant. Bond issue of $90,000 has been approved. Work is scheduled to begin soon. Engineering Service Co., Railway Exchange Building, Kansas City, Mo., is consulting engineer.

N. Y., Lancaster—Hazel-Atlas Glass Co., Wheeling, W. Va., plans installation of electric power equipment in new addition to glass jar manufacturing plant at Lancaster. Entire project will cost close to $100,000.

N. C., Charlotte—City Council, J. B. Marshall, city manager, will receive bids until July 6 for equipment for municipal waterworks, including motor-driven pumping machinery and auxiliary equipment for Catawba River pumping station, three elevated steel tanks and towers, pipe lines and other equipment. This is part of a $1,000,000 waterworks expansion and improvement program.

Ohio, Cincinnati—Chevrolet Motor Co., 3044 West Grand Boulevard, Detroit, Mich., a division of General Motors Corporation, plans extensions and improvements in power plant at branch automobile works at 4726 Smith Road, Norwood, Cincinnati. Cost reported close to $200,000, including equipment.

Ore., Blachly—Blachly-Lane County Co-operative Electric Association, Blachly, plans steam-electric generating plant on local site for power service for rural electric lines in parts of Lane County. Entire project will cost over $100,000. Financing has been arranged through Federal aid.

S. D., Flandreau—City Council is arranging immediate call for bids for new municipal electric light and power station on South Prairie Street, including equipment installation. Cost about $239,000, of which $169,000 will be represented by bond issue and $70,000 by Federal grant. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, is consulting engineer.

Wash., Tacoma—Water Department, Tacoma, plans installation of electric power equipment in new municipal equipment plant and shop for waterworks division. Entire project will cost about $125,000. W. A. Kunigk is city water superintendent.